CONTROLLED DOCUMENT

Model 3705/3707 PCM/VF Communications Test System

User's Manual

HEKIMIAN LABORATORIES, INC.

9298 Gaither Road
Gaithersburg, Maryland 20877 USA
AN AXEL JOHNSON INC. COMPANY

Telephone (301) 590-3500
Telex 215080 HEKIM UR
Telecopier (301) 840-0476

Model 3705/3703 PCM/VF
Communications Test System
Copyright ©1984,1989 Hekimian Laboratories, Inc.
Unpublished -- all rights reserved

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_07042

TABLE OF CONTENTS

SECTION 1. INTRODUCTION

SECTION 2. EQUIPMENT DESCRIPTIONS

SECTION 3. INSTALLATION

SECTION 4. FRONT PANEL-CONTROLLED OPERATION

SECTION 5. REMOTE-CONTROLLED OPERATION

SECTION 6. MAINTENANCE

MODEL 3700 OPTION .72 EASYTEST™ EDITOR/RAM BUFFER USER'S MANUAL

GLOSSARY

SECTION 1 - INTRODUCTION

CONTENTS PAGE

1.1 Purpose of this Manual 1-1
1.2 How to Use this Manual 1-1
1.3 Related Documentation 1-2
1.4 Revisions to this Manual 1-2

1.1 Purpose of this Manual

This manual provides the information needed to understand and use the Model 3705 and 3707 Communications Test Systems (CTSs). (The Model 3705 and 3707 differ only in mode of operation. The Model 3705 is equipped for front panel-controlled operation; remote-controlled operation is optional. The Model 3707 is equipped *only* for remote-controlled operation.) Specifically, this manual contains information that:

- Explains the purpose and capabilities of the Model 3705/3707 CTS.
- Describes the components used in the unit.
- Explains how to install, operate, and maintain the CTS.

The manual is intended to be a training aid to teach new users about the system, and a reference manual for users already familiar with the system.

1.2 How to Use this Manual

Use the following descriptions to become familiar with the contents of the manual.

SECTION 1 - INTRODUCTION describes how to use this manual. This section also lists related documentation.

SECTION 2 - EQUIPMENT DESCRIPTIONS provides both physical and functional descriptions of the CTS. This section describes standard CTS configurations and all options that can be ordered.

SECTION 3 - INSTALLATION provides instructions for installing and initializing the CTS for operation.

SECTION 4 - FRONT PANEL-CONTROLLED OPERATION describes how to operate the Model 3705 using front panel controls.

SECTION 5 - REMOTE-CONTROLLED OPERATION describes how to operate the Model 3705/3707 CTS through a remote test position.

SECTION 6 - MAINTENANCE provides corrective maintenance information for the CTS. This section also describes how to interpret error messages.

MODEL 3700 OPTION .72 EASYTEST™ EDITOR/RAM BUFFER USER'S MANUAL describes how to create EasyTest™ procedures using Option .72.

GLOSSARY - The glossary describes abbreviations and acronyms applicable to Hekimian test, access, and network management equipment.

1.3 Related Documentation

If the CTS is part of a REACT 2000 Network Management System, the following documents may be helpful.

HKMN 660-750-020 REACT Analog Testing REACT 2000 System, Issue 6.

HKMN 660-750-021 REACT Channelized Testing REACT 2000 System, Issue 5.

1.4 Revisions to this Manual

Issue 7 of this manual supports Model 3705/3707 Firmware Revision 15.05.

Issue 7, replaces Issue 6, change 1 of September 1989.

SECTION 2. MODEL 3705/3707 EQUIPMENT DESCRIPTIONS

CONTENTS

PAGE

2.1 Equipment Overview 2-2
2.1.1 PCM/VF Testing Configurations 2-2
2.1.2 PCM/VF With Data Testing Configurations 2-4
2.1.3 Wideband PCM/VF Testing Configurations 2-4
2.1.4 Wideband PCM/VF With Data Testing Configurations 2-4
2.1.5 PCM/ISDN/DDS Loop Qualification Configuration 2-5
2.2 Functional Description 2-5
2.2.1 Digital Testing 2-5
2.2.2 Analog Testing 2-6
2.2.3 Dial/Talk Capability 2-6
2.2.4 Remote-Control Operation 2-7
2.3 Physical Description 2-7
2.3.1 Model 3705 Front Panel Description 2-8
2.3.2 Model 3705/3707 Rear Panel Description 2-9
2.4 Options 2-10
2.4.1 Basic Unit Options 2-12
2.4.2 Remote Control Options 2-12
2.4.3 Analog Measurements Options 2-13
2.4.4 PCM Measurements Options 2-15
2.5 Equipment Specifications 2-15

FIGURES

PAGE

2-1 Model 3705 and 3707 Communications Test Systems 2-3
2-2 Model 3705 Front Panel Callout 2-8
2-3 Model 3705/3707 Rear Panel Callout 2-9

TABLES

PAGE

2-1 Model 3705/3707 Physical Characteristics 2-7
2-2 Option List 2-11
2-3 Model 3705/3707 w/Option .64 Specifications 2-16
2-4 Option .07 X-Y Outputs Specifications 2-24
2-5 Option .12 and .12A Envelope Delay Specifications 2-25
2-6 Option .13 Hits/Jitter Specifications 2-26
2-7 Option .25A Remote Control Specifications 2-28
2-8 Option .30 Intermodulation Distortion and P/AR Specifications 2-30
2-9 Option .35C Call Progress and Signaling Specifications 2-31
2-10 Option .40 VOM/CAP Specifications 2-33
2-11 Option .41 Master/Slave Specifications 2-35
2-12 Option .52 Responder Interface Specifications 2-36
2-13 Option .65 T1 Bit Error Ratio Specifications 2-37

2.1 Equipment Overview

The Model 3705 and 3707 PCM/VF Communications Test Systems (CTSs) are shown in Figure 2-1. In addition to performing a wide range of IEEE Std 743/Bell PUB 41009 analog measurements, these units perform a full complement of pulse code modulation (PCM) error measurements. Additional features and measurement capabilities are available through plug-in option boards.

The Model 3705/3707 CTS interfaces directly with:

- Superframed, extended superframed, and SLC-96™ T1 lines
- Digital Cross-connect System (DCS) test digroups
- 2-wire or 4-wire analog circuits

The Model 3705 CTS can be used as a portable or rack-mounted instrument. This unit is equipped for front panel-controlled operation; remote-controlled operation is optional. A built-in dial/talk feature allows dialing and communication on the line under test. Measurement parameters and results are presented on a 40-character alphanumeric display.

The Model 3707 CTS is a rack-mounted unit designed only for remote-controlled operation. It includes Option .25A Remote Control, which can be ordered with either an RS-232-C or IEEE 488 interface.

Both CTSs are available in a variety of configurations designed for specific applications. The following paragraphs describe these configurations.

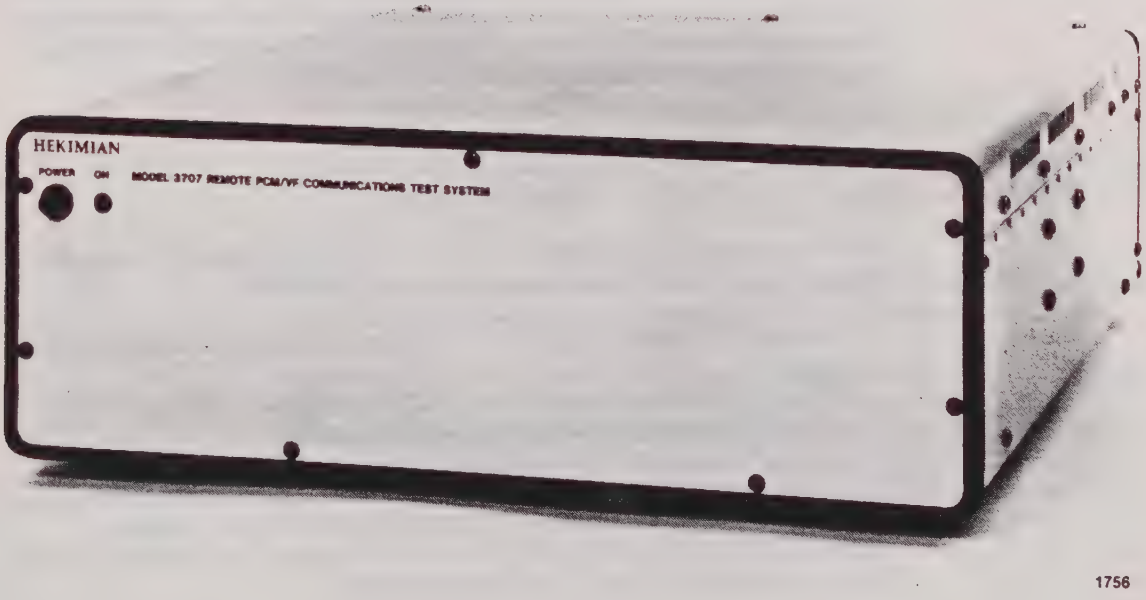
2.1.1 PCM/VF Testing Configurations

The following configurations support PCM and standard voice-frequency (VF) circuit testing:

- Model 3705-20 Basic Portable PCM/VF Test System (US), 115 Vac power
- Model 3707-14 Basic Remote-Only PCM/VF Test System (US), RS-232-C interface, -48 Vdc power, EasyTest™ Editor

These units include PCM access and test capability for level and frequency, noise, signal-to-noise ratio, three-level impulse noise, and return loss. (These configurations do *not* support measurement of VF data transmission parameters.) The frequency measurement range for these units is from 40 to 20,100 Hz. These units are equipped for DTMF and MF signaling.

Model 3705 CTS



Model 3707 CTS

Figure 2-1. Model 3705 and 3707 Communications Test Systems

2.1.2 PCM/VF With Data Testing Configurations

The following configurations support PCM, standard VF, and VF data circuit testing:

- Model 3705-22 Basic Portable PCM/VF Data Test System (US), 115 Vac power
- Model 3707-17 Basic Remote-Only PCM/VF Data Test System (US), RS-232-C interface, -48 Vdc power, EasyTest™ Editor

These units include PCM access and test capability for level and frequency, noise, signal-to-noise ratio, three-level impulse noise, return loss, envelope delay, hits/jitter, intermodulation distortion and P/AR. Frequency measurement range for these units is from 40 to 20,100 Hz. These units are equipped for DTMF and MF signaling.

2.1.3 Wideband PCM/VF Testing Configurations

The following configurations support PCM and standard voice-frequency (VF) and wideband circuit testing with a frequency measurement range of 40 to 120,000 Hz:

- Model 3705-24 Basic Portable PCM/Wideband Test System (US), 115 Vac power
- Model 3707-18 Basic Remote-Only PCM/Wideband Test System (US), RS-232-C interface, -48 Vdc power, EasyTest™ Editor

These units include PCM access and test capability for level and frequency, noise, signal-to-noise ratio, three-level impulse noise, and return loss. (These configurations do *not* support measurement of VF data transmission parameters.) These units are equipped with 15 kHz flat and 50 kilobit filters, and DTMF and MF signaling capability.

2.1.4 Wideband PCM/VF With Data Testing Configurations

The following configurations support PCM, standard VF, and wideband VF data circuit testing with a frequency measurement range of 40 to 120,000 Hz:

- Model 3705-25 Basic Portable PCM/Wideband Data Test System (US), 115 Vac power
- Model 3707-19 Basic Remote-Only PCM/Wideband Data Test System (US), RS-232-C interface, -48 Vdc power, EasyTest™ Editor

These units include PCM access and test capability for level and frequency, noise, signal-to-noise ratio, three-level impulse noise, return loss, envelope delay, hits/jitter, intermodulation distortion and P/AR. These units are equipped with 15 kHz flat and 50 kilobit filters, and DTMF and MF signaling capability.

2.1.5 PCM/ISDN/DDS Loop Qualification Configuration

The following configuration supports ISDN and DDS loop testing:

- Model 3705-23 Portable PCM/ISDN/DDS Test System (US), 115 Vac power

This unit includes PCM access and test capability for level and frequency, noise, signal-to-noise ratio, three-level impulse noise, return loss, and VOM/CAP measurements. This CTS is equipped with 15 kHz flat and 50 kilobit filters, and DTMF and MF signaling capability. The frequency measurement range is from 40 to 120,000 Hz.

2.2 Functional Description

This section describes the digital and analog testing capabilities of the CTS. It also describes the dial/talk and remote-control features of the system.

2.2.1 Digital Testing

The Model 3705/3707 CTS can interface directly to either a T1 line or a DCS test digroup. It can perform the following in-service PCM error measurements:

- Bipolar violations
- Excessive zeroes
- Frame bit errors
- Multiframe bit errors (superframed only)
- CRC errors (ESF only)
- Frame alignment alarms
- Remote frame alignment alarms
- Loss of digital transmission
- Errored seconds

If the CTS is equipped with Option .65 T1 Bit Error Ratio, then the unit can generate test patterns and perform a variety of out-of-service PCM bit error measurements.

When testing PCM circuits, access to the selected T1 channel or DCS test access digroup (TAD) can be in either a nonintrusive monitor mode or in a drop-and-insert mode. The CTS provides D/A conversion in the monitor mode to allow analog monitoring of the selected channel. The status of bit-robbed signaling bits or single frequency (SF) signaling can also be monitored in this mode. In the drop-and-insert mode, a test signal generated by the Model 3705/3707 CTS is inserted in the selected PCM channel.

The Model 3705/3707 CTS may be configured in any one of three test modes for PCM testing:

- INLINE for testing in-service circuits while unselected channels are passed through undisturbed.
- TERMINAL for looped testing of channel banks while idle channel code (01111111) is transmitted to unselected channels.
- DCS for testing circuits through a DCS TAD while unselected ports are passed through undisturbed.

NOTE: DCS permits daisy-chaining of multiple Model 3705/3707 CTSs on a single DCS TAD.

The Model 3705/3707 CTS can detect and generate supervisory signaling used in some PCM transmissions. Specifically, the CTS can:

- Detect and generate bit-robbed or SF supervision in both directions.
- Detect and generate wink signals.
- Provide FXO and FXS signaling and control functions.

2.2.2 Analog Testing

In addition to digital testing, the Model 3705/3707 CTS can also test analog circuits to IEEE Std 743/Bell PUB 41009 specifications. The standard Model 3705/3707 CTS measures 40 Hz to 20 kHz level and frequency, noise, signal-to-noise ratio, three-level impulse noise, and 2-wire and 4-wire return loss. The analog circuit interface accommodates both 2-wire and 4-wire circuits. Other features include:

- Multifunction signal generator.
- Independent selection of send and receive impedances of 135, 600, 900, or 1200 ohms (bridged or terminated receive).
- Send/receive line reversal.
- Dual hold circuits.
- Internal and external dialing capability for dial pulse, DTMF, or MF digits.

A wide range of options are available to expand the analog test capabilities of the Model 3705/3707 CTS.

2.2.3 Dial/Talk Capability

Dialing and communication features are included in the Model 3705/3707 CTS. You can monitor either side of a 4-wire circuit, whether analog or digital, and talk on the send side of the line under test. For 2-wire circuits, the CTS features dual hold and keypad dialing of dial pulse, DTMF, or MF digits. The Model 3705 CTS front panel includes a numeric keypad for dialing, a speaker for monitoring and talking on the circuit, and a jack for connecting a handset. The dialing features are fully functional on both analog and PCM circuits.

The Model 3705/3707 CTS dial/talk features both manual and automatic dialing operation. In automatic dial, up to 99 registers with up to 40 digits may be entered and then dialed with a single key press. The dialing may also be conditioned on wink detection.

2.2.4 Remote-Control Operation

The Model 3705/3707 CTS can be configured to fit a wide variety of remote-controlled test applications. By including the EasyTest™ Editor option, you can create, edit, and store complex test sequences unique to your requirements. Then, with one command, you can run the stored test sequence. In computer-controlled test systems, the EasyTest™ Editor enables you to load test sequences from the computer to the Model 3705/3707 CTS.

2.3 Physical Description

Model 3705/3707 CTS physical characteristics are summarized in Table 2-1. The Model 3705 is a portable unit; rack mounting hardware is optional. The Model 3707 is a rack-mountable unit designed specifically for remote-controlled applications. The CTSs include a quick-release front cover that protects the front panel while the unit is in storage or in transport. (The cover contains a storage compartment for storing the detachable ac power cord.) All operating controls and indicators are mounted on the front panel. The rear panel includes a power fuse and connectors for power and line connections.

TABLE 2-1. MODEL 3705/3707 PHYSICAL CHARACTERISTICS

CHARACTERISTICS	SPECIFICATIONS
Dimensions	15.0 in. (38.1 cm) W, 5.25 in. (13.3 cm) H, 18.5 in. (47.0 cm) D
Weight	20.5 lbs. (9.3 kg)
Environment	
Operating	+32 to +122°F (0 to +50°C) 5 to 95% relative, humidity, without condensation
Storage	-40 to +158°F (-40 to +70°C) 5 to 95% relative humidity, without condensation

2.3.1 Model 3705 Front Panel Description

The front panel components described in this section are shown in Figure 2-2.

① **Display Control Switches** control the function of the 40-character alphanumeric display. In the MEAS mode, the measurement status and test results are displayed; in the SET UP mode, test parameters are selected and displayed.

② **40-Character Display** is used to select measurement parameters or to display measurement status and test results.

③ **Soft Keys** are used with the display to define test functions or to set up test parameters.

④ **Power Switch** controls the primary power to the Model 3705 CTS.

⑤ **Test Lines Section** contains the VF SEND and RCV jacks, the DIAL/TALK jack, the PCM DCS, EAST, and WEST IN/OUT jacks, the LINE key for line interface set-up, and the DIAL/TALK key for 2-wire dial/talk and 4-wire talk. The rear panel barrier strip connections are normalized through the front panel jacks. Therefore, when plugs are inserted into the front panel jacks, the rear panel barrier strip connections are interrupted.

⑥ **Generator Section** contains the control keys used to set up the generator and control the sweep functions and quiet termination.

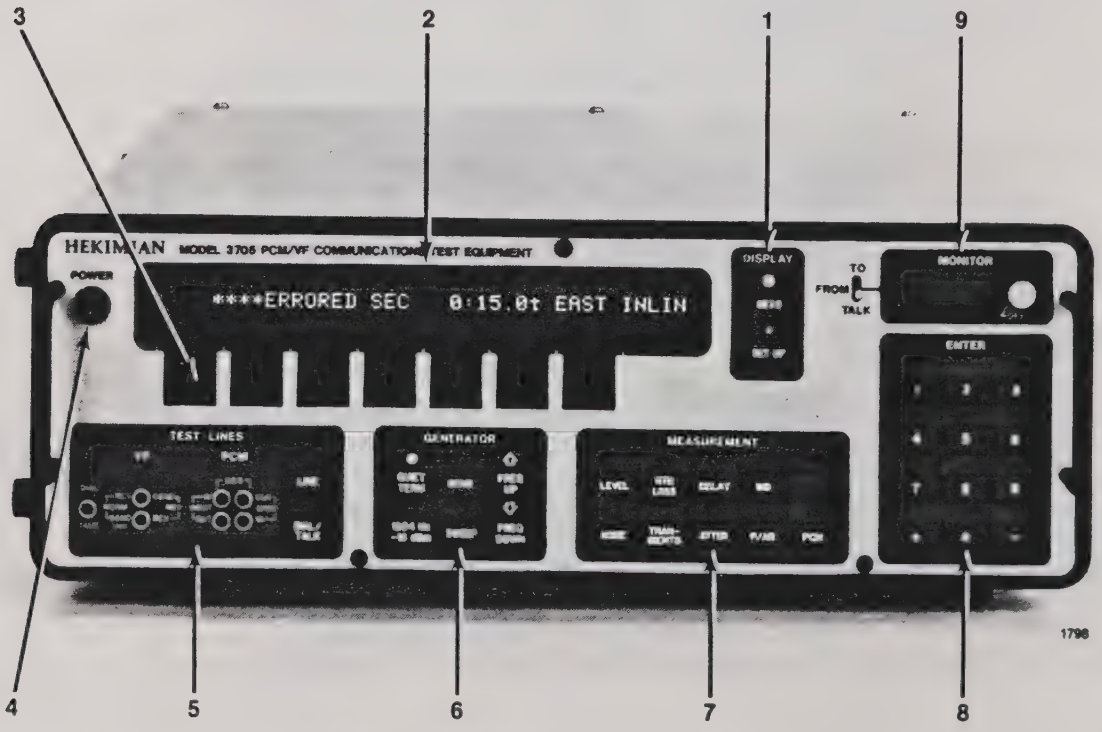


Figure 2-2. Model 3705 Front Panel Callout

⑦ **Measurement Section** contains the control keys used to select the type of measurement that appears on the display in both SET UP and MEAS modes. The LED will light when the measurement is active.

⑧ **Enter Keypad** is used for entering set up parameters and for using the internal dial capability.

⑨ **Monitor Section** controls the monitor source and talk/listen controls for dial/talk. The volume control adjusts the listening level and includes an OFF position. The speaker is also used as a microphone for the internal talk capability.

2.3.2 Model 3705/3707 Rear Panel Description

The rear panel components described in this section are shown in Figure 2-3.

① **Remote Control Interface Connector** is used to connect the remote-control option (Option .25A-232 or Option .25A-488).

② **Facility Data Link Connectors** provide access to receive and send signals on the ESF facility data link. The interface is at RS-232-C levels.

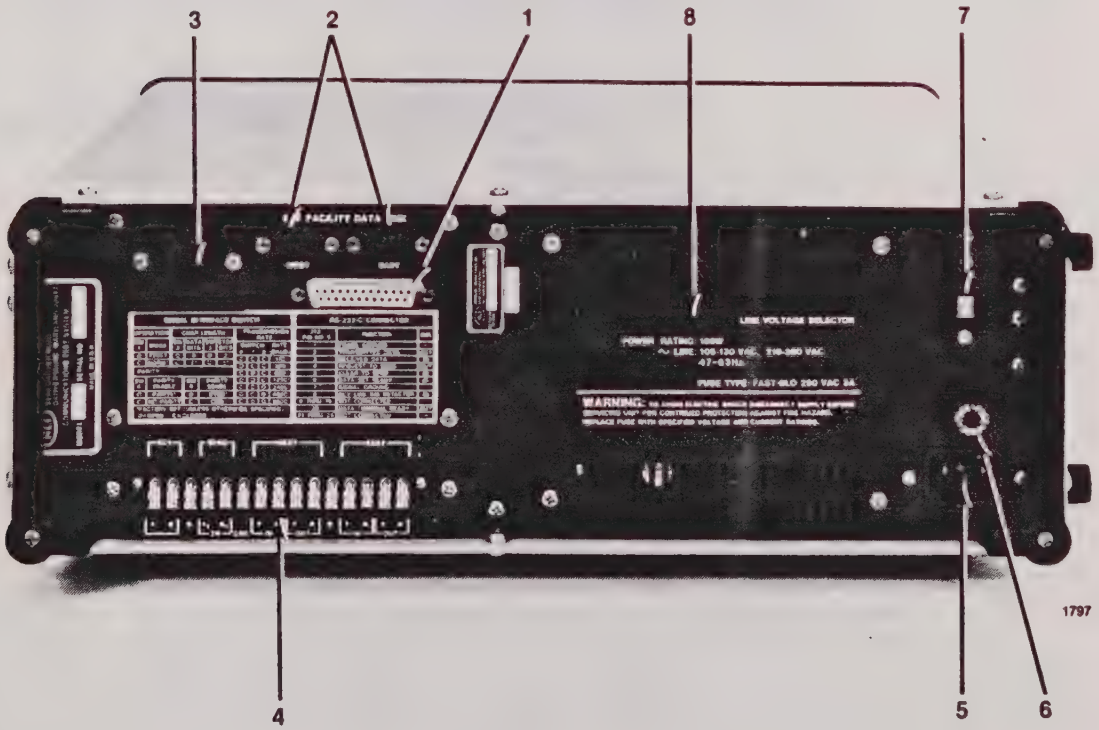


Figure 2-3. Model 3705/3707 Rear Panel Callout

③ **Remote Control Interface DIP Switch** is used for set up of the remote-control option (Option .25A-232 or Option .25A-488) interface parameters.

④ **Test Line Connections** are wired to the normalling contacts on the corresponding front panel jacks, both PCM and VF.

⑤ **AC Power Receptacle** is used with a detachable ac power cord. This receptacle is replaced by a barrier strip for -48 Vdc Option .06 or -24 Vdc Option .06A.

⑥ **Fuse Holder** contains the primary power safety fuse.

⑦ **AC Line Voltage Selector Switch** configures the unit to operate with either 115 or 230 ac line voltage. This switch is not installed with Option .06 or .06A.

⑧ **Power Rating, Fuse Type Information Label** lists the primary power requirements and replacement fuse information.

(not shown) **Optional Connections Barrier Strip** is provided with Option .35A or .35C Call Progress and Signaling. X-Y Output connections are also provided when Option .07 is included.

2.4 Options

Table 2-2 lists options for the Model 3705/3707 CTS. Descriptions of the options are provided in the following paragraphs.

NOTE: Some options described in Table 2-2 are now included as standard items. Contact Hekimian for availability of specific options.

TABLE 2-2. OPTION LIST

OPTION	DESCRIPTION
.01	Rack Mounting
.06[1]	-48 Vdc Operation
.06A[1]	-24 Vdc Operation
.07[1]	X-Y Outputs
.08	4Z I/O
.09	20 kHz Basic Unit Operation
.10[1]	120 kHz Basic Unit Operation
.11	Three-Level Impulse Noise
.12A (.12)	Envelope Delay
.13	Hits/Jitter
.14	Intermodulation Distortion
.15[2]	15 kHz Flat/Program Filters
.15B[2]	15 kHz Flat/50 kb Filters
.15C[2]	15 kHz Flat/50 kb/50 kHz Filters
.16	Return Loss
.18A (.18)	P/AR
.25A-232	Remote Control (RS-232-C Interface)
.25A-488	Remote Control (IEEE 488 Interface)
.30	Intermodulation Distortion and P/AR
.35A	Call Progress and Signaling
.35C	Call Progress and Signaling
.40	VOM/CAP
.41[3]	Master/Slave
.52	Responder Interface
.60	DTMF/MF Signaling
.62	PCM Test/Channel Access
.64	ESF PCM Test/Channel Access
.65[6]	Requires Option .64 ESF PCM Test/Channel access.
.70	EasyTest™ Interpreter
.71-001	Basic EasyTest™ Procedure Set
.71-002[4]	Master/Slave EasyTest™ Procedure Set
.71-004	REACT EasyTest™ Procedure Set
.71-007[4]	Enhanced Master/Slave and REACT EasyTest™ Procedure Set
.72[5]	EasyTest™ Editor
.74	RAM Buffer

[1]Must be specified when ordering the Model 3705/3707 Basic Unit.
[2]Only one Option .15 can be included. Option .15, .15B, or .15C can be supplied mounted to an Option .18A, 19, or .30 so only one long wide option slot is used.
[3]For remote operation only. Requires Option .25A-232 (RS-232-C Interface).
[4]Requires Option .41 Master/Slave and Option .25A-232 (RS-232-C Interface).
[5]Requires Option .25A.
[6]Requires Option .64 ESF PCM Test/Channel Access

2.4.1 Basic Unit Options

Option .01 Rack Mounting allows the Model 3705/3707 CTS to be rack-mounted in one of four ways:

- Flush-mounted in a 19-inch rack.
- Flush-mounted in a 23-inch rack.
- Forward-projection mounted in a 19-inch rack.
- Forward-projection mounted in a 23-inch rack.

Refer to Section 5 for detailed information.

Option .06 -48 Vdc Operation replaces the ac supply and allows the Model 3705/3707 CTS to operate with -48 Vdc primary power instead of 115/230 Vac primary power. A rear panel barrier strip is included for primary power connections.

Option .06A -24 Vdc Operation replaces the ac supply and allows the Model 3705/3707 CTS to operate with -24 Vdc primary power instead of 115/230 Vac primary power. A rear panel barrier strip is included for primary power connections.

Option .07 X-Y Outputs enables you to use an X-Y recorder with the Model 3705/3707 CTS. The X-Y recorder allows you to graph test data when permanent records are required. DC outputs are provided for level, delay, and frequency measurements. AC output is provided for a demodulated phase or amplitude jitter. This option plugs into a short option slot in the Model 3705/3707 CTS. Connections are made through a rear panel barrier strip.

Option .08 4Z I/O, now standard in all 3700-series CTSs, provides four terminating impedances for VF I/O; 135 ohms, 600 ohms, 900 ohms, and 1200 ohms.

Option .09 20 kHz Basic Unit Operation, now standard on all 3700-series CTSs, extends the transmission and measurement frequency range to 40 to 20,100 Hz.

Option .10 120 kHz Basic Unit Operation extends the transmission and measurement frequency range to 40 to 120,000 Hz, with few specification changes.

2.4.2 Remote Control Options

Options .25A-232 or .25A-488 Remote Control provides the software control and interfaces to allow the CTS to be used in a variety of remote-controlled test applications. Available with either RS-232-C or IEEE 488 interfaces, it uses stored program control to perform complex measurement sequences as directed by a simple set of commands.

Option .41 Master/Slave is designed to be used with Option .25A-232 Remote Control (RS-232-C Interface) for remote CTS operation and the collection of data over the 4-wire line under test. When installed in both the near- and far-end remote-controlled Model 3705/3707 CTS, Option .41 allows the operator to control the test functions of the far-end CTS, including collection of the far-end measurements over the line under test. The option provides a full-duplex data modem and automatic test signal/data signal control. Option .41 is compatible with other Hekimian CTSs that include the Master/Slave feature.

Option .70 EasyTest™ Interpreter adds the EasyTest™ language to Option .25A, and is supplied with all Option .25A equipped 3700-series CTSs.

Option .71-001 Basic EasyTest™ Procedure Set is a basic set of EasyTest™ procedures supplied with Option .25A and .70. Only one Option .71 may be installed.

Option .71-002 Master/Slave EasyTest™ Procedure Set adds EasyTest™ procedures that simplify master/slave operation of the Model 3705/3707 CTS in conjunction with Option .41 and Option .25A-232. These procedures include two-way C-conditioning, attenuation distortion, envelope delay, and two-way D-conditioning on 4-wire facilities.

Option .71-004 REACT EasyTest™ Procedure Set adds the EasyTest™ procedures needed to operate in REACT 2000 System applications.

Option .71-007 Enhanced Master/Slave and REACT EasyTest™ Procedure Set combines the REACT EasyTest™ Procedures Set with an enhanced version of master/slave procedures which can function on 2-wire or 4-wire mixed facilities. The test performed are 2-way IEEE Std 743/Bell PUB 41009 VF and data tests such as envelope delay, intermodulation distortion, hits, phase and amplitude jitter, and P/AR.

Option .72 EasyTest™ Editor allows you to create, edit, and modify EasyTest™ procedures, and down-load procedures from a controller.

Option .74 RAM Buffer permits measurement results to be stored for later collection, and provides memory for the Option .72 EasyTest™ Editor to store, edit, and modify procedures. This option is standard with all Option .25A equipped CTSs.

2.4.3 Analog Measurements Options

Option .11 Three-Level Impulse Noise measures and displays the number of impulse noise occurrences. Designed to IEEE Std 743/Bell PUB 41009 specifications, it provides a full three-level impulse noise distribution. This option is standard on all Model 3700s with Firmware Revision 12 or later.

Option .12A (.12) Envelope Delay, designed to IEEE Std 743/Bell PUB 41009 specifications, measures and displays envelope delay distortion. It provides forward reference and return reference delay, and an amplitude repeat mode to provide loop measurement capability. Option .12A replaces the previously-available Option .12 Envelope Delay in units with Firmware Revision 12 or later.

Option .13 Hits/Jitter measures and displays phase hits, gain hits, dropouts, phase and amplitude jitter in accordance with IEEE Std 743/Bell PUB 41009. It provides a comprehensive measurement of short-term transient effects and incidental phase and amplitude modulation that affects signals transmitted through a telephone channel.

Option .14 Intermodulation Distortion measures and displays second and third order intermodulation distortion. Option .14 is designed to IEEE Std 743/Bell PUB 41009 specifications, and CCITT O.42 Recommendations. It measures channel intermodulation distortion using the 4-tone technique that supersedes obsolete harmonic and total distortion measurement methods.

Option .15 15 kHz Flat/Program Filters adds 15 kHz flat and U.S. program weighting filters (C-message and 3 kHz flat noise weighting filters are standard).

Option .15B 15 kHz Flat/50 kb Filters add 15 kHz flat and 50 kilobit weighting filters.

Option .15C 15 kHz Flat/50 kb/50 kHz Flat Filters add 15 kHz flat, 50 kilobit, and 50 kHz flat weighting filters. This option only works in units with Option .10 120 kHz operation.

Option .16 Return Loss provides full 2-wire and 4-wire return loss measurement capability. Designed to IEEE Std 743/Bell PUB 41009 specifications, it allows ERL, SRL LO and SRL High and sine-wave measurements to be made by the CTS. The option incorporates generators for all required test signals and the echo suppressor disable tone. In units with Firmware Revision 12 or later, Option .16 is supplied as part of the basic unit.

Option .18A (.18) P/AR measures and displays the P/AR rating of a channel. Designed to IEEE Std 743/Bell PUB 41009, P/AR (peak-to-average ratio) is a rating of the simultaneous effects of envelope delay distortion, frequency response problems, and poor return loss on voiceband data signals. Option .18A replaces the previously available Option .18 in units equipped with Firmware Revision 12 or later.

Option .30 Intermodulation Distortion and P/AR measures and displays second and third order intermodulation distortion and the P/AR rating of a channel. Option .30 is designed to IEEE Std 743/Bell PUB 41009 specifications, and CCITT O.42 Recommendations. It measures channel intermodulation distortion using the 4-tone technique that supersedes obsolete harmonic and total distortion measurement methods. P/AR (peak-to-average ratio) is a rating of the simultaneous effects of envelope delay distortion, frequency response problems, and poor return loss on voiceband data signals. Option .30 works only in units equipped with Firmware Revision 12 or later.

Option .35A Call Progress and Signaling allows the Model 3705/3707 CTS to operate in loop signaling (loop-start and ground-start) and E & M (Types I, II, III, IV, and V) signaling systems. Option .35A provides the required supervisory signaling and detection, and also features call progress tone detection. This feature enhances the operation of remote-controlled and automated REACT (Remote Access and Test) Systems. With Option .35A installed, test personnel can monitor call progress from a remote test control device. Option .35A can also detect DTMF tones.

Option .35C Call Progress and Signaling performs all the loop-start, ground-start, and E & M signaling functions of the Option .35A, plus it adds Single Frequency (SF) signaling. In addition to the Option .35A DTMF tone detector, the Option .35C also detects MF tones and dial pulse digits. The Option .35C performs call progress tone detection as does the Option .35A.

Option .40 VOM/CAP measures ac and dc voltage and current, plus resistance and capacitance. Option .40 uses a sampled data measurement technique to provide excellent measurement resolution and accuracy. This technique also reduces the effects of foreign voltage and background interference on the resistance and capacitance measurements.

Option .52 Responder Interface permits the Model 3705/3707 CTS to act as a near-end responder for 105-type testing, and performs CAROT-type measurements with far-end 52- and 56A-type responders. The measurements performed are loss, gain slope, noise-with-tone, C-message noise, and return loss. The option is designed to Bellcore Compatibility Bulletin CB 106. Option .52 also requires Option .60 for operation.

Option .60 DTMF/MF Signaling adds DTMF/MF tone dialing capability to the CTS. Option .60 plugs into a short option slot in the CTS. In units with Firmware Revision 12 or later, Option .60 is supplied as part of the basic unit, and requires no plug-in board.

2.4.4 PCM Measurements Options

Option .62 PCM Test/Channel Access adds PCM testing capability to units originally supplied without Option .62.

Option .64 ESF PCM Test/Channel Access adds PCM channelized testing for digital circuits with superframed (D1D, D2, D3D4), extended superframe (ESF), and SLC-96™ framing formats.

Option .65 T1 Bit Error Ratio adds out-of-service bit error ratio measurements to units equipped with Option .64 ESF PCM Test/Channel Access. The Option .65 operates at both the DS-1 (1.544 Mbps) and channelized (64 kbps) ratio. The option generates pseudorandom test patterns, user defined patterns, all 1s, and 3 in 24 stress pattern; as well as CSU, SMJ, and RDL loop-up and loop-down codes. The Option also performs error injection, and provides an unique frequency difference measurement.

2.5 Equipment Specifications

This section contains the following tables which further detail specifications for the Model 3705/3707 and options:

- Table 2-3 Model 3705/3707 w/Option .64 Specifications
- Table 2-4 Option .07 X-Y Outputs Specifications
- Table 2-5 Option .12A Envelope Delay Specifications
- Table 2-6 Option .13 Hits/Jitter Specifications
- Table 2-7 Option .25A Remote Control Specifications
- Table 2-8 Option .30 Intermodulation Distortion and P/AR Specifications
- Table 2-9 Option .35C Call Progress and Signaling
- Table 2-10 Option .40 VOM/CAP Specifications
- Table 2-11 Option .41 Master/Slave Specifications
- Table 2-12 Option .52 Responder Interface Specifications
- Table 2-13 Option .65 T1 Bit Error Ratio Specifications

NOTE: Hekimian reserves the right to make changes in specifications at any time without notice.

TABLE 2-3. MODEL 3705/3707 w/OPTION .64 SPECIFICATIONS

PCM GENERAL	
Operating Mode	Channel access from a digital T1 line, or from a DCS test digroup in Monitor/Idle, or Drop-and-Insert.
Digital Code	Standard DS-1 frame formats D1D, D2, D3D4, Extended Superframe Format (ESF), SLC-96™; AMI or B8ZS selectable.
Companding Law	μ=255 coding
VF GENERAL	
Operating Mode	2W (2-wire) and 4W (4-wire) analog circuits
Impedance	600Ω, 900Ω, 1200Ω, bridged/150 Vdc blocking; 135Ω, no dc blocking
Bridging Loss	<0.2 dB, 200 Hz to 20 kHz (135Ω, 20 kHz to 120 kHz - Option .10)
Balance	>80 dB @ 60 Hz
Return Loss	>30 dB, 200 Hz to 20 kHz (>15 dB, 20 kHz to 120 kHz - Option .10)
Input Filter	50 kHz corner frequency, except Option .10
Hold/Dial/Talk	4W talk, 2W talk with dual hold circuits, and internal and external dial capability for dial pulse, DTMF, or MF digits
Automatic Dial	Stores up to 99 sets of up to 40 digits
Monitor	To/From/Talk signal switch, volume control
PCM MEASUREMENTS	
Alarms Displayed	No PCM Remote Frame Alignment Alarm Frame Alignment Alarm AIS (All 1s)
Totalizers	
Types	Bipolar violations Excessive zeroes Frame bit errors Multiframe bit errors (superframed only) CRC errors (ESF only) Errored seconds Frame alignment alarms Remote frame alignment alarms No PCM alarms
Count Capacity	0 through 9999
Timer Duration	0.1 minute to 100 hours

TABLE 2-3. MODEL 3705/3707 w/OPTION .64 SPECIFICATIONS (continued)

VF MEASUREMENTS*

Level/Frequency**

Level	+10 through -70 dBm (+10 through -50 dBm - Option .10)
Frequency	40 Hz through 20.1 kHz (40 Hz through 120 kHz - Option .10)
Measurement Accuracy	±0.1 dB @ 1000 Hz, 0 through -19 dBm ±0.2 dB @ 200 Hz through 15 kHz, +10 through -50 dBm ±0.5 dB @ 40 Hz through 20 kHz, +10 through -50 dBm (±0.5 dB @ 20 through 70 kHz, +10 through -40 dBm - Option .10) (±1.0 dB @ 70 through 120 kHz, +10 through -40 dBm - Option .10)
Frequency Resolution	1 Hz, 40 Hz through 20.1 kHz (10 Hz, 20.1 kHz through 120 kHz - Option .10)
Frequency Level Range	+10 through -50 dBm
Frequency Accuracy	±1 Hz ±0.01% of reading through 20.1 kHz
Rel. Ref. Range	+10.0 through -40.0 dBm
TLP Range	+10 through -40 dBm, 1 dB resolution
High Pass Filter	>20 dB loss @ 60 Hz, selectable

Noise

Filters	C-Message, 3 kHz Flat, 1010 Hz notch Program and 15 kHz Flat - Option .15 50 kilobit and 15 kHz Flat - Option .15B (15 kHz Flat, 50 kilobit, and 50 kHz Flat - Option .15C and .10)
Range	10 through 100 dBrn (20 through 100 dBrn - Option .10) 40 through 130 dBrn noise-to-ground (50 through 130 dBrn noise-to-ground - Option .10)
Accuracy	±1.0 dB ±1.5 dB noise-to-ground

Signal-to-Noise

Level Range	+10 through -40 dBm
Noise Range	20 through 90 dBrn
S/N Range	+10 through +45 dB
Accuracy	±1 dB through +40 dB
Weighting	C-Notch

*Refer to option list for optional capabilities.
**The PCM channel range and frequency response is less than the VF capabilities.

TABLE 2-3. MODEL 3705/3707 w/OPTION .64 SPECIFICATIONS (continued)

Three-Level Impulse Noise* **	
Measurement Range	30 through 110 dBrn 40 through 110 dBrn with Program, 15 kHz Flat, 50 kilobit, and 15 kHz Flat -Options .15 and .15B (40 through 110 dBrn with 15 kHz Flat, 50 kilobit, and 50 kHz Flat - Options .15C and .10)
Low Threshold	
Range	30 through 106 dBrn 40 through 106 dBrn with Program, 15 kHz Flat, 50 kilobit, and 15 kHz Flat - Options .15 and .15B (40 through 110 dBrn with 15 kHz Flat, 50 kilobit, and 50 kHz Flat - Options .15C and .10)
Settability	1 dB
Accuracy	±1 dB
Lo/Mid, Mid/High Threshold Spread	2, 4, 6, or 8 dB
Count	
Rate	7 counts/second (Bell standard) or 100 counts/second (fast mode)
Capacity	9999 for LO, MID, and HI threshold totalizers
Weighting	C-Message 15 kHz Flat - Option .15, .15B, or .15C Program - Option .15 50 kilobit - Option .15B or .15C 50 kHz Flat - Option .15C and .10; with or without 1010 Hz test tone notch
Counting Hierarchy	When used with Option .13 Hits/Jitter, impulse noise counts are interlocked with hit and drop-out occurrences per Bell PUB 41009.
Return Loss	
Operating Modes	4-wire return loss 2-wire return loss
Receive Weighting	
Normal	Flat with 60 Hz high pass filter
C-Message (ERL only)	C-Message and 60 Hz high pass filters

*** All stated and unstated specifications are intended to comply with n Bell System Technical Reference PUB 41009 dated May 1975.

TABLE 2-3. MODEL 3705/3707 w/OPTION .64 SPECIFICATIONS (continued)

Measurement Range	-10 through +50 dB (4W) 0 through +50 dB (2W)
Accuracy	±0.5 dB
Echo Suppressor Disable Tone	Provides nominal 1-second burst of 2.15 kHz tone to disable any echo suppressors in test path.
Transhybrid Loss Correction (4-Wire)	±99.9 dB
Generator	
Test Signals	SRLHI, SRLLO, ERL, designed to meet industry standard weighting, and sine wave
Level Range	0.0 through -70.0 dBm rms
Level Stability	±0.5 dB
Harmonic Distortion	At least 30 dB down
2W Reference Impedance Selection	600Ω in series with 2.16 µF 900Ω in series with 2.16 µF 1200Ω in series with 2.16 µF External reference (NORM-RCV jack)

PCM CIRCUITS DIGITAL INTERFACE

Input

Rate	1.544 Mbps ±200 bps
Pulse Level	
Terminated	±100 mV to ±3V base-to-peak
Bridge	±1V to ±3V base-to-peak
Impedance	
Terminated	100Ω ±10%, balanced
Bridge	>1000Ω, balanced

Output

Rate	Slaved to received PCM or 1.544 Mbps ±40 bps in Terminal Master Mode
Pulse Level	±3V base-to-peak ±10% into 100Ω
Impedance	100Ω ±10%, balanced

TABLE 2-3. MODEL 3705/3707 w/OPTION .64 SPECIFICATIONS (continued)

Operating Modes		
In-Line		
	Monitor	Unmodified receive signal (if line code properly selected)
	Drop-and-Insert	Received signal with BPV removed and selected channel modified
Terminal		
	Idle	Idle channel code (01111111) in all channels
	Drop-and-Insert	Idle channel code (01111111) in all except selected channel
DCS		
	Monitor	Unmodified receive signal (if line code properly selected)
	Drop-and-Insert	Received signal with BPV removed and selected test port modified
PCM CIRCUITS		
ANALOG INTERFACE		
Decoding		
	Accuracy	0.0 ±0.1 dBm with digital mW applied
	Frequency Response	±0.15 dB from 300 Hz through 3 kHz
	Noise	Idle channel code received, ≤19 dBrnC0
	Channel Selection	Channel in selected direction decoded for measurement and signaling. Channel in other direction decoded for signaling only.
Encoding		
	Accuracy	±0.1 dB @ 0 dBm, 1 kHz
	Frequency Response	±0.15 dB from 300 Hz to 3 kHz
	Noise	Idle channel noise with input quiet-terminated, ≤19 dBrnC0
	Channel Selection	Channel in selected direction encoded for measurement and signaling. Channel in other direction encoded for signaling only.
Decoding and Encoding		
	Minimum Signal to Quantization Distortion	10 through -30 dBm0 input level: Output, 35 dB Input, 35 dB Overall, 33 dB
		-30 through -40 dBm0 input level: Output, 29 dB Input, 29 dB Overall, 27 dB
		-40 through -45 dBm0 input level: Output, 25 dB Input, 25 dB Overall, 22 dB

TABLE 2-3. MODEL 3705/3707 w/OPTION .64 SPECIFICATIONS (continued)

Maximum Tracking Gain Error	+3 through -37 dBm0 input level:	Output, 0.25 dB Input, 0.25 dB Overall, 0.50 dB
	-37 through -50 dBm0 input level:	Output, 0.50 dB Input, 0.50 dB Overall, 1.00 dB

SIGNALING

PCM

Channel Selection	Slaved to channel selected for analog testing
Control	Signaling state directly controlled by user
Features	Wink detection, dial pulsing, and FX-type supervision
Digital Bit	
Superframe	A and B; bit-robbed
ESF	A, B, C, and D; bit-robbed
Single Frequency (SF)	
Send Frequency	2604 Hz, ±1 Hz
Send Level	-8 and -20 dBm0
Receiver Sensitivity	-29 dBm0, guarded detection with guard release

VF Loop-start supervisory signaling; dial pulse, DTMF or MF digits

DTMF/MF Signaling

DTMF Digits	
Tone Duration	80 ms
Interdigit Interval	80 ms
MF Digits	
Tone Duration	
KP1, KP2	120 ms
All others	75 ms
Interdigit Interval	75 ms
Frequency Accuracy	±0.7%
Level Accuracy	±0.5 dB, composite rms
Amplitude Twist	0 dB, nominal

TABLE 2-3. MODEL 3705/3707 w/OPTION .64 SPECIFICATIONS (continued)

VF SIGNAL GENERATOR	
Frequency Range**	40 through 20,004 Hz (40 Hz through 120 kHz - Option .10)
Frequency Accuracy	±0.01%
Frequency Resolution	1 Hz with selectable steps of 1, 10, 100, or 1000 Hz (also 10 kHz - Option .10)
Frequency Offset	
1 Hz step	No offset
All others	4 Hz offset
Level Range	+10 through -70 dBm, 0.1 dB resolution
Level Accuracy**	±0.1 dB @ 1000 Hz, 0 through -19 dBm ±0.2 dB @ 40 Hz through 15 kHz, +10 through -40 dBm ±0.5 dB @ 15 through 20 kHz, +10 through -40 dBm (±1.0 dB @ 20 through 120 kHz, +10 to -40 dBm - Option .10)
Modes	1004 Hz @ -16 dBm, manual set, automatic sweep, quiet termination, loopback tone (2713 Hz)
SF Skip Range	2450 through 2750 Hz
Distortion	> 50 dB down from fundamental, 100 Hz through 4 kHz > 40 dB down from fundamental, 4 through 20 kHz (> 40 dB down from fundamental, 4 through 120 kHz - Option .10)
Sweep Rates	0.3, 1, or 3 steps/second
CONNECTORS	
Digital	
PCM	Normalling Bantam jacks (4), rear panel barrier strip
ESF Facility Data Link	DB-9S (2) RS-232-C, synchronous interface
Analog	Normalling Bantam jacks (2), rear panel barrier strip
Dial/Talk	Bantam jack (1)
POWER REQUIREMENTS	
Standard	105-130/210-260 Vac (switch-selectable), 47-63 Hz, 80 watts maximum depending on options selected
Option .06	-48 Vdc nominal, 40-60 Vdc, 80 watts maximum
Option .06A	-24 Vdc nominal, 20-30 Vdc, 80 watts maximum
SIZE	15 in.(38.1 cm) W x 5.25 in.(13.3 cm) H x 18.5 in.(47 cm) D
WEIGHT	20.5 lb. (9.3 kg)

TABLE 2-3. MODEL 3705/3707 w/OPTION .64 SPECIFICATIONS (continued)

ENVIRONMENTAL REQUIREMENTS	
Temperature Range	
Operating	0 to 50 °C
Storage	-40 to +70 °C
Humidity	
Operating and Storage	5 to 95 % relative humidity, without condensation

TABLE 2-4. OPTION .07 X-Y OUTPUTS SPECIFICATIONS

OUTPUTS	
Level	
Range	+1 through -4 Vdc, corresponding to measured level range of +10 through -40 dBm
Scale	0.1 V/dB
Resolution	0.2 dB
Frequency	
Range	0 through +5 Vdc, corresponding to sweep limit to high sweep limit
Scale	0.042 through 19.5 V/kHz, dependent on sweep range
Resolution	Sweep range divided by 256, or 1 Hz, whichever is greater
Delay	
Range	±5 Vdc, corresponding to measured delay range of ±10 ms
Scale	0.5 V/ms
Resolution	5 µs
Options Required	Option .12 Envelope Delay
Phase Jitter/ Amplitude Jitter	
Range	0 to 3 Vac peak
Scale	0.1 V/° (phase jitter) 0.1 V/% (amplitude jitter)
Options Required	Option .13 Hits/Jitter
OUTPUT ACCURACY	
Phase Jitter/ Amplitude Jitter	±5% of indication
Level, Frequency, and Delay	Basic unit or applicable option accuracy ± 2% of full scale
OUTPUT IMPEDANCE	2,000 Ω
EXTERNAL CONNECTIONS	Rear panel barrier strip
OPTION SIZE	1 short option slot
WEIGHT	4 oz. (114 g)

TABLE 2-5. OPTION .12 AND .12A ENVELOPE DELAY SPECIFICATIONS

OPERATING MODES	
Delay	Master
Delay	Slave
Delay plus Amplitude	Slave
DELAY MEASUREMENT (Master and Slave)	
Carrier Frequency Range	200 Hz through 4 kHz
Carrier Level Range	+10 through -40 dBm
Modulation Frequency	83-1/3 Hz
Delay Measurement	+9000 through -3000 µs
Accuracy	±10 µs, 600 Hz through 4000 Hz ±30 µs, 300 Hz through 600 Hz
AMPLITUDE REPEAT (Slave Only)	
Carrier Range	+10 through -40 dBm
Accuracy	±0.5 dB
GENERATOR	
Carrier	Uses basic unit generator
Modulation Distortion	More than 55 dB below carrier
DISPLAY AVERAGING	
Normal	20 periods of modulation frequency
Damped	160 periods of modulation frequency
ZERO REFERENCE	Push-to-set zero reference for delay measurement
MEASUREMENT DISPLAY	Receive level (dBm/dBm0) Receive or send frequency (kHz) Delay (µs) Caution flags: INV LEVEL INV SIG
OPTION SIZE	1 long option slot
WEIGHT	10 oz. (284 g)

TABLE 2-6. OPTION .13 HITS/JITTER SPECIFICATIONS

OPERATING MODES	
Hits	Phase hits Gain hits
Jitter	Dropouts Phase jitter Amplitude jitter
RECEIVE HOLDING TONE (All Measurements)	
Frequency Range	
Hits	995 Hz through 1025 Hz
Jitter	990 Hz through 1030 Hz
Level Range	+10 dBm through -40 dBm
PHASE HIT MEASUREMENT	5° through 50° peak in 5° steps
GAIN HIT MEASUREMENT	±1 through ±10 dB in 1 dB steps
DROPOUT MEASUREMENT	12, ±1 dB
GUARD INTERVAL	4 ms (hits, dropouts)
COUNT	
Rate	Standard (7 counts/second) Fast (100 counts/second)
Capacity	9999 maximum (for all totalizers)
HITS/IMPULSE INTERLOCK*	When used with Impulse Noise Option .11, impulse noise counts are interlocked with hit and dropout occurrences.
TIMER	
Range	1 through 60 minutes, and continuous up to 4 days
Resolution	1 minute
Display Resolution	0.1 minute
PHASE JITTER MEASUREMENT	0.0° through 30.0° peak-to-peak
AMPLITUDE JITTER MEASUREMENT	0.0% to 30.0% peak
ACCURACY	±5% of reading, ±2 least significant digits
WEIGHTING	Standard (20 Hz - 300 Hz) Standard + LF (extended low frequency range)

*All stated and unstated specifications are intended to comply with n Bell System Technical Reference PUB 41009 dated May 1975.

TABLE 2-6. OPTION .13 HITS/JITTER SPECIFICATIONS (continued)

GENERATOR	1004 Hz holding tone supplied by Basic Unit generator
SELF-TEST	
Phase Jitter	21.4 ±1.3 degrees peak-to-peak
Amplitude Jitter	18.6 ±1.1% peak
MEASUREMENT DISPLAYS	
Hits	Phase hit totalizer Gain hit totalizer Dropout totalizer Timer (min.) Caution Flag (INV SIG)
Jitter	Phase (°peak-to-peak) Amplitude (% peak) Receive level (dBm) Receive frequency (kHz)
OPTION SIZE	1 long option slot
WEIGHT	11 oz. (312 g)

TABLE 2-7. OPTION .25A REMOTE CONTROL SPECIFICATIONS

GENERAL	
Type	Microprocessor based
Control	Stored program
VERSIONS	
.25A-232	RS-232-C Interface
.25A-488	IEEE 488 Interface
RS-232-C INTERFACE	
Specification	Per EIA RS-232-C August 1969
Character Type	ASCII
Rate	110, 300, 600, 1200, 4800, 9600 bps asynchronous; switch selectable
Word Length	7 or 8 bits; selectable
Stop Bits	1 or 2 bits; selectable
Parity	Odd, even or none; selectable
Mode	Full duplex
IEEE 488 INTERFACE	
Specification	Per IEEE Std 488-1978
Type	Talker/Listener
Address	Switch programmable
States Supported	SH1, AH1, T6 or TE6, L4 or LE4, SR1, RL1, PP1, DC1, DTO, and C0
COMMAND LANGUAGE	
Mnemonics	4 alphabetical characters
EasyTest™	Programmed test sequences
SPECIAL FEATURES	
Data Buffering	Storage of test results to be retrieved at user's discretion (Option .74 Data Buffer is standard in Option .25A)
Printer Drive Mode	Permits results on display to be routed to serial interface printer, with Option .25A-232
Calendar Clock	Allows printing of minute, hour, day, month, and year
Battery Back-up	Non-volatile storage of user-entered test sequence

TABLE 2-7. OPTION .25A REMOTE CONTROL SPECIFICATIONS (continued)

OPTIONS	
EasyTest™ Editor	User programmable EasyTest™ procedures (Option .72) available for .25A-232 and .25A-488
Master/Slave EasyTest™	C-conditioning tests
CONNECTORS	
RS-232-C	DB-25S industry standard
IEEE 488	24-pin receptacle per standard
OPTION SIZE	1 long option slot
WEIGHT	13 oz. (369 g)

TABLE 2-8. OPTION .30 INTERMODULATION DISTORTION and P/AR SPECIFICATIONS

INTERMODULATION DISTORTION MEASUREMENTS	
Input Signal Level Range	0 through -40 dBm
Test Frequencies	857, 863, 1372 and 1388 Hz
Distortion Product Frequencies	2nd order; centered at 520 and 2240 Hz 3rd order; centered at 1900 Hz
S/N Test	Deletes one tone pair and raises level of remaining tone pair by 3 dB
Distortion Measurement	
Range	10 through 70 dB below signal for 2nd and 3rd order products
Resolution	1 dB
Accuracy	±1 dB
4-Tone Signal Generator	
Level Range	+0.0 through -70.0 dBm rms
Level Accuracy	±1 dB
Harmonic Distortion	35 dB or more below individual tone level
Self-Test	35 dB 2nd and 3rd order products
Specifications	Bell Pub 41009, IEEE Std 743, CCITT Recommendation O.42
PEAK-TO-AVERAGE (P/AR) MEASUREMENTS	
Level Range	0 through -40 dBm
Measurement Range	0 through 120 P/AR units
Detection	Full-wave rectified average detector and absolute peak
Accuracy	±2 P/AR units (30-110 units) ±4 P/AR units (0-120 units)
Resolution	1 P/AR unit
Line Signal Stability	64 ms period, ± 0.1%
Self-Test	59 P/AR unit test signal
Specifications	Bell Pub 41009, IEEE Std 743
OPTION SIZE	1 long option slot
WEIGHT	9 oz. (256 g)

TABLE 2-9. OPTION .35C CALL PROGRESS AND SIGNALING SPECIFICATIONS

E&M SIGNALING	
Types Accommodated	Types I, II, II, IV, and V
Detection Capability	Busy/Idle on E&M leads
Control Capability	Thru, split, independent seizure of E or M leads
GROUND-START SIGNALING	
Detection Capability	Tip ground Busy/Idle/Ring
Control Capability	Ring ground Loop closure (with Model 3701 hold circuit) Battery feed
LOOP-START SIGNALING	
Detection Capability	Busy/Idle/Ring Reverse battery
Control Capability	Loop closure (with Model 3701 hold circuit) Battery feed
SF SIGNALING	
Detection Capability	SF present or absent
Detection Bandwidth	±30 Hz at 2600 Hz
Detection Sensitivity	
Maximum	+6 dBm0 (must detect)
Minimum	-28 dBm0 (must detect) -30 dBm0 (must not detect)
Control Capability	SF on or off (2600 Hz, 8 dB and 20 dB below send level setting)
WINK DETECTION	
Short Wink	Less than 100 ms
Wink	100 ms through 350 ms
Off Hook	Greater than 350 ms
No Detection	No off-hook interval
Sources	Reverse battery, E or M lead, SF, or A/B bit if equipped with Option .62

TABLE 2-9. OPTION .35C CALL PROGRESS AND SIGNALING SPECIFICATIONS (continued)

CALL PROGRESS TONE DETECTION	
Tones Detected	
Dial Tone	350 & 440 Hz, 525 & 660 Hz, or 480 & 620 Hz
Line Busy	480 & 620 Hz, 60 interruptions per minute
Trunk Busy	480 & 620 Hz, 120 interruptions per minute
Tone Level Range	0 through -35 dBm each tone
Allowable Twist	±10 dB
ADDRESS TONE DETECTION	
DTMF	
Tones Detected	DTMF digits 0 through 9, *, #, and A-D
Tone Duration	40 ms detect
Interdigit Duration	40 ms must respond
Tone Level Range	0 through -25 dBm0 composite
MF	
Tones Detected	MF digits 0 through 9, KP1, KP2, ST, Code 11 and 12
Tone Duration	55 ms must detect KP1, KP2 30 ms must detect all other tones
Interdigit Duration	30 ms must respond
Tone Level Range	0 through -25 dBm0 each tone
Allowable Twist	±6 dB
DIAL PULSE DETECTION	
Pulses per Second	3 through 13 pps at 60% BK
Percent Break	45 through 70% at 10 pps
Sources	Loop status, E or M lead, SF, or A/B bit if equipped with Option .62
OPTIONS	Non-standard call progress tone detection
OPTION SIZE	1 long option slot 1 short option slot
WEIGHT	1 lb. 8 oz. (609 g)

TABLE 2-10. OPTION .40 VOM/CAP SPECIFICATIONS

DISPLAY RESOLUTION	
All Measurements	3 digits maximum
DC VOLTAGE	
Range	0.0 through ±200 Vdc
Accuracy	±2% of reading ±0.2 Vdc
Input Resistance	10 MΩ
AC VOLTAGE	
Range	0.0 through 160 Vac
Accuracy	±3% of full scale (20 Hz through 5 kHz)
Input Impedance	10 MΩ shunted by approximately 100 pF
Detector Response	Average responding, sine wave rms calibrated
DC CURRENT	
Range	0.0 through ±200 mA
Accuracy	±2% of reading ±0.2 mA
Voltage Burden	300 mV (1Ω fuse)
AC CURRENT	
Range	0.0 to 200 mA
Accuracy	±3% of full scale (20 Hz through 5 kHz)
Voltage Burden	300 mV (1Ω fuse)
Detector Response	Average responding, sine wave rms calibrated
RESISTANCE	
Range	
Low	0.000 through 99.9 kΩ 0.100 through 2.00 MΩ
High	0.000 through 20.0 MΩ
Accuracy	±2% of reading. Resistance is measured using a 100 Vdc source to minimize the effect of foreign voltages.
Maximum Output Current	1.0 mAdc
CAPACITANCE	
Range	
Low	0.00 through 5.00 µF
High	0.00 through 20.0 µF

TABLE 2-10. OPTION .40 VOM/CAP SPECIFICATIONS (continued)

Accuracy	±2% of reading. Capacitance is measured using a 100 Vdc source.
Maximum Output Current	1.0 mAdc
OVERLOAD PROTECTION	
Overload Protection Circuit	During ac and dc current measurements, overload protection circuit interrupts test connection if an overload occurs. A fuse is also provided for severe overload protection in the ac and dc current and capacitance modes.
Fuse	Bussman GMT TYPE fuse, 1-1/3A, 125 Vac/60 Vdc
OPTION SIZE	1 long option slot
WEIGHT	16 oz. (454 g)

TABLE 2-11. OPTION .41 MASTER/SLAVE SPECIFICATIONS

OPTIONS REQUIRED	Option .25A-232 Remote Control (RS-232-C)
FACILITY CONFIGURATION	4-wire
INPUT SIGNAL REQUIREMENTS	
Level Range	+7 through -30 dBm per tone
Skew	9 dB (1.1 through 2.1 kHz)
TRANSMISSION RATE	300 bps
MODEM FREQUENCIES	
Mark	1270 Hz
Space	1070 Hz
PILOT FREQUENCY	2114 Hz
SEND LEVEL RANGE	+10.0 through -70.0 dBm (total signal is 3 dB higher)
MEASUREMENT DELAY RANGE*	0 through 99 seconds
PATH CONTROL CHARACTER*	<ESC>, ↑[, ASCII 1B or as programmed with SESC command
CONNECTOR*	DB-25P industry standard
OPTION SIZE	1 short option slot
WEIGHT	5 oz. (142 g)

*Option .25A-232 feature.

TABLE 2-12. OPTION .52 RESPONDER INTERFACE SPECIFICATIONS

MODE OF OPERATION	
Near-End	Model 3700 System simulates a near-end responder under direct control of the front panel or remote-control option.
LINE INTERFACE	4-wire or 2-wire; 600, 900 or 1200 ohms
MEASUREMENTS	
Types	Loss (2-way) 0.4 kHz Gain Slope (2-way) 1.0 kHz Gain Slope (2-way) 2.8 kHz Gain Slope (2-way) C-Notch Noise (2-way) Near-End Noise Far-End Noise SRLLO Return Loss (2-way) ERL Return Loss (2-way) SRLHI Return Loss (2-way) Self Checks
Level Ranges	
Loss	+2.0 through -15.8 dBm
Gain Slope	-14.0 through -36.9 dBm
Level Accuracy	
Loss	±0.1 dB @ 1.0 kHz
Gain Slope	±0.2 dB @ 0.4, 1.0, and 2.8 kHz
Noise Ranges	
C-Messages	15 through 55 dBrnC
C-Notch	34 through 74 dBrnC
Noise Accuracy	±1 dB
Return Loss Ranges	0 through 40 dB
Return Loss Accuracy	±1 dB
Detection	
Level	Average responding rms calibrated
Noise and Return Loss	Quasi-rms
OPTIONS REQUIRED	Option .60*, DTMF/MF Signaling
OPTION SIZE	1 long option slot
WEIGHT	11 oz. (312 g)

*Option .60 is standard on all CTSs with Firmware 12 or later.

TABLE 2-13. OPTION .65 T1 BIT ERROR RATIO SPECIFICATIONS

OPERATING MODES	
Framing Formats	Unframed (UF) Superframed (SF) Extended superframed (ESF) SLC-96™
Line Coding	Alternate Mark Inversion (AMI) Bipolar Eight Zero Substitution (B8ZS)
PCM Interface	(Refer to Option .64 ESF PCM data sheet)
T1 MEASUREMENTS	
Errors Detected	Bipolar violations Frame errors Bit errors CRC block errors
Reporting Measurements	Totals since a test began Last 1000 errored seconds (time stamped)* Totals in each 15-minute interval during test*
Test Results Reported	Bit error ratio Errored second** (synchronous or asynchronous) Severely errored seconds (synchronous or asynchronous) Degraded minutes Percent error free seconds (synchronous or asynchronous) Signal status** Bipolar violation ratio Synchronization lost seconds (frame and pattern) Number of synchronization losses (frame and pattern) Unavailable time
FREQUENCY DIFFERENCE MEASUREMENT	
Resolution	1 or 0.1 Hz
Accuracy	±0.1% ±4 or 0.4 Hz
Sources	East in, west in, internal clock
Update Rate	1 or 10 seconds, selectable
T1 TEST PATTERN GENERATION	
Data Patterns	511, 2047, 2^{15}-1, 2^{20}-1, 2^{23}-1 pseudorandom; QRSS; user-defined 8-, 16-, and 24-bit repetitive; All 1s; Alternating ones and zeroes; 3-in-24 stress pattern

*Remotely-controlled operations only.
**Measurement made

TABLE 2-13. OPTION .65 T1 BIT ERROR RATIO SPECIFICATIONS (continued)

Timing Source	Internal clock or loop-timed from either receive direction
Generated Data Rate	1.544 Mbps ±40 bps (internal clock)***
Keep-Alive Signal	All 1s, unframed
CHANNELIZED MEASUREMENTS	
Errors Detected	Pattern bit errors, pattern slips
Test Results Reported	Pattern bit error ratio Errored Seconds Severely Errored Seconds Degraded minutes Percent error free seconds Pattern slips Synchronization lost seconds (pattern) Unavailable Time
Channel Selection	One of 24, clear channel or B8=1
CHANNELIZED TEST PATTERN GENERATION	
Data Patterns	511, 2047, 2^{15}-1, 2^{20}-1, 2^{23}-1 pseudorandom; QRSS; user-defined 8-, 16-, and 24-bit repetitive
Generated Data Rate	64 kbps or 56 kbps derived from internal clock or loop-timed from either receive direction
ROUND TRIP DELAY MEASUREMENT	
Range	0 to 1000 msec
Resolution	1 msec
Accuracy	±0.5 msec
Rate	56 or 64 kbps
LOOPING CODE GENERATION	
CSU	
SF	loop-up: 10000, loop-down: 100
ESF	per Bellcore TR-TSY-000194, line and payload
SMJ	
SF	loop-up: 11000, loop-down: 11100
ESF	per Bellcore TR-TSY-000194
RDL (56 or 64 kbps)	per CCITT Recommendation V.54

***Internal clock is a feature of Option .64 ESF PCM

TABLE 2-13. OPTION .65 T1 BIT ERROR RATIO SPECIFICATIONS (continued)

ERROR INJECTION	
Bit Errors	Injected as a burst of 1 to 99 bit errors or at a controlled ratio from 1 x 10^{-9} to 2 x 10^{-3} errors/bit
Type	Bit errors or framing pattern bit errors
Bipolar Violations	Injected as a burst of 1 to 99 BPVs or at a controlled ratio from 1 x 10^{-9} to 2 x 10^{-3} BPVs/bit
OPTION SIZE	1 long option slot****
WEIGHT	1 lb. 2 oz. (511 g)

****Option .65 can only be used in Model 3705/3707 CTSs equipped with Option .64 ESF PCM

SECTION 3 - MODEL 3705/3707 INSTALLATION

CONTENTS

PAGE

3.1 Rack-Mounting Instructions 3-2
3.1.1 Rack-Mounting Options 3-2
3.1.2 Environmental Considerations 3-2
3.1.3 Unpacking and Inspection 3-2
3.1.4 Rack-Mounting the Unit 3-2
3.2 Primary Power Connections 3-7
3.2.1 AC Power Connection 3-7
3.2.2 DC Power Connection 3-8
3.3 Setup Instructions for Remote Control Operation 3-9
3.3.1 Setup Instructions for RS-232-C/CCITT V.24 Serial Interface 3-10
3.3.1.1 Setting the RS-232-C Interface DIP Switch 3-11
3.3.1.2 Connecting Devices to the RS-232-C Interface Connector 3-12
3.3.2 Setup Instructions for IEEE 488 Interface 3-13
3.3.2.1 Setting the IEEE 488 Interface DIP Switch 3-14
3.3.2.2 Connecting Devices to the IEEE 488 Interface Connector 3-16
3.4 Setup Instructions for Printer Mode Operation 3-17
3.5 Line Under Test Connections 3-17
3.6 Facility Data Link Connections 3-17

FIGURES

PAGE

3-1 19-Inch Rack, Flush Mounting 3-3
3-2 23-Inch Rack, Flush Mounting 3-4
3-3 19-Inch Rack, Forward Projection 3-5
3-4 23-Inch Rack, Forward Projection 3-6
3-5 AC Power Receptacle, Line Voltage Selector Switch and Fuse Locations 3-8
3-6 Terminals for DC Power Connection 3-9
3-7 Battery Jumper Installation 3-10
3-8 RS-232-C Interface DIP Switch and Connector 3-11
3-9 RS-232-C Interface DIP Switch Settings 3-12
3-10 IEEE 488 Interface DIP Switch and Connector 3-15
3-11 Internal Interface DIP Switch 3-16

TABLES

PAGE

3-1 Serial Interface Connector Pin Assignments 3-13
3-2 Rear-panel DIP Switch Configuration 3-14
3-3 Internal Interface DIP Switch Configuration 3-15
3-4 Option .25A-488 Interface Connector Pins 3-17
3-5 Facility Data Link Connector Pin Assignments 3-18
3-6 Facility Data Link Connector Direction 3-18

3.1 Rack-Mounting Instructions

This section describes how to mount the CTS in either 19- or 23-inch equipment racks.

3.1.1 Rack-Mounting Options

Using Option .01, the CTS can be rack-mounted in equipment bays. Option .01 versions for flush mounting and 5-inch forward projection mounting for both 19- and 23-inch equipment racks. These versions can be ordered by product number as follows:

Product	Description
3700-07	Opt .01 19" Flush Rack Mount
3700-08	Opt .01 23" Flush Rack Mount
3700-09	Opt .01 19" Forward Projected Rack Mount
3700-15	Opt .01 23" Forward Projected Rack Mount

3.1.2 Environmental Considerations

The CTS should not be mounted such that air flow through the chassis vents is impeded. Restricting the air flow may lead to overheating of the unit and possible damage. With proper ventilation, the CTS will operate at ambient temperatures as high as 50 degrees C. To provide proper ventilation, a 1.75-inch space above and below the CTS is recommended. The unit should also not be exposed to excessive humidity or moisture which may condense on or in the unit. Moisture from condensation may cause unit failure.

3.1.3 Unpacking and Inspection

Remove the CTS from its shipping container and perform a complete visual inspection for possible damage. If damage is found, notify the carrier's agent immediately. Retain all packing material and the shipping container for the carrier's inspection. If the carrier's agent is not available, please contact Hekimian Customer Support at (301) 590-3500. Do *not* return the instrument to Hekimian Laboratories, Inc., until a claim for damage has been established.

3.1.4 Rack-Mounting the Unit

Figures 3-1 through 3-4 provide rack-mounting details. There are no unique requirements for mounting the CTS in an equipment rack. Mounting ears are designed with slotted mounting holes spaced on standard 2.25 inch vertical hole centers for ease of alignment. No mounting hardware is supplied with the unit.

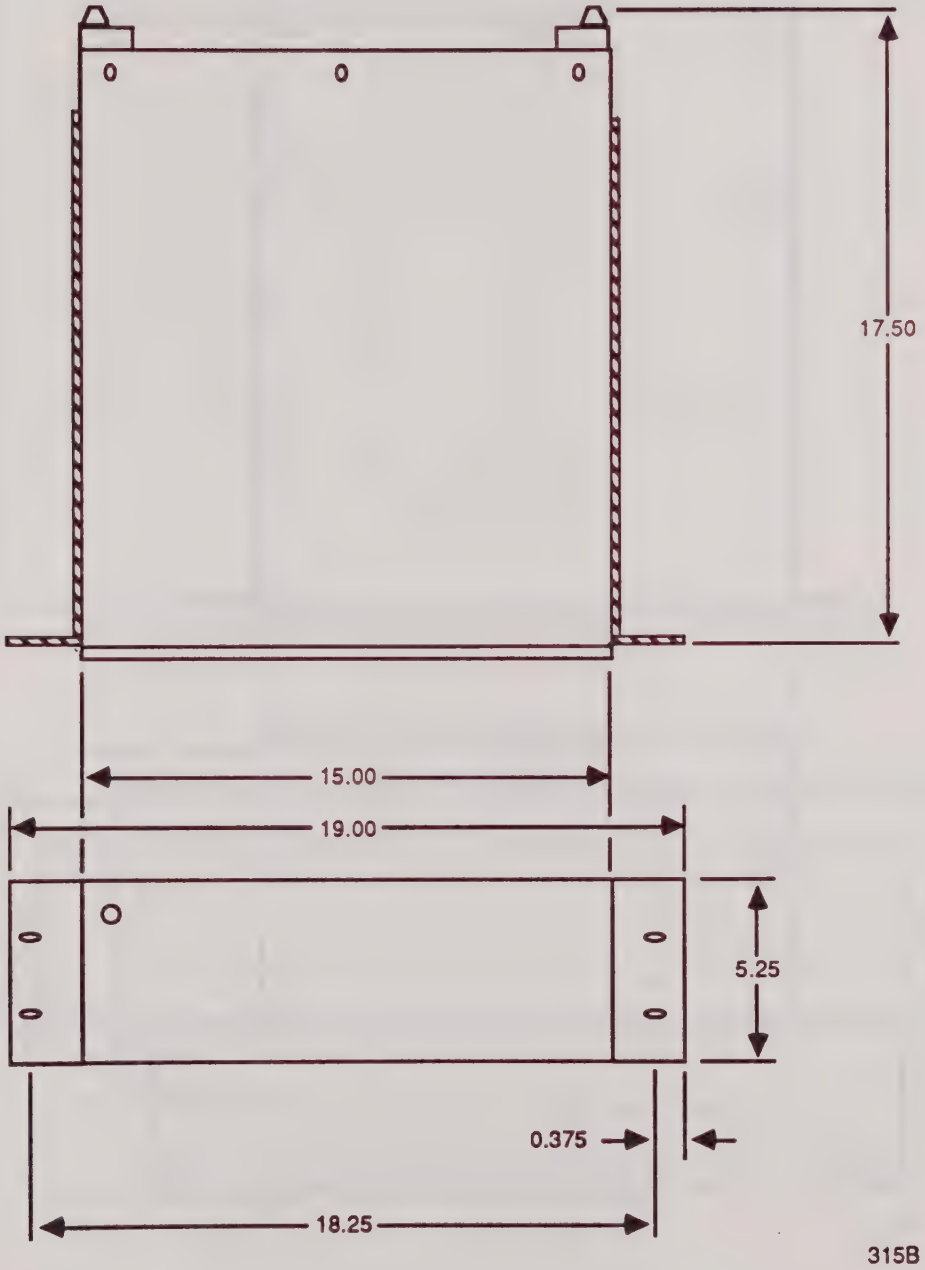


Figure 3-1. 19-Inch Rack, Flush Mounting

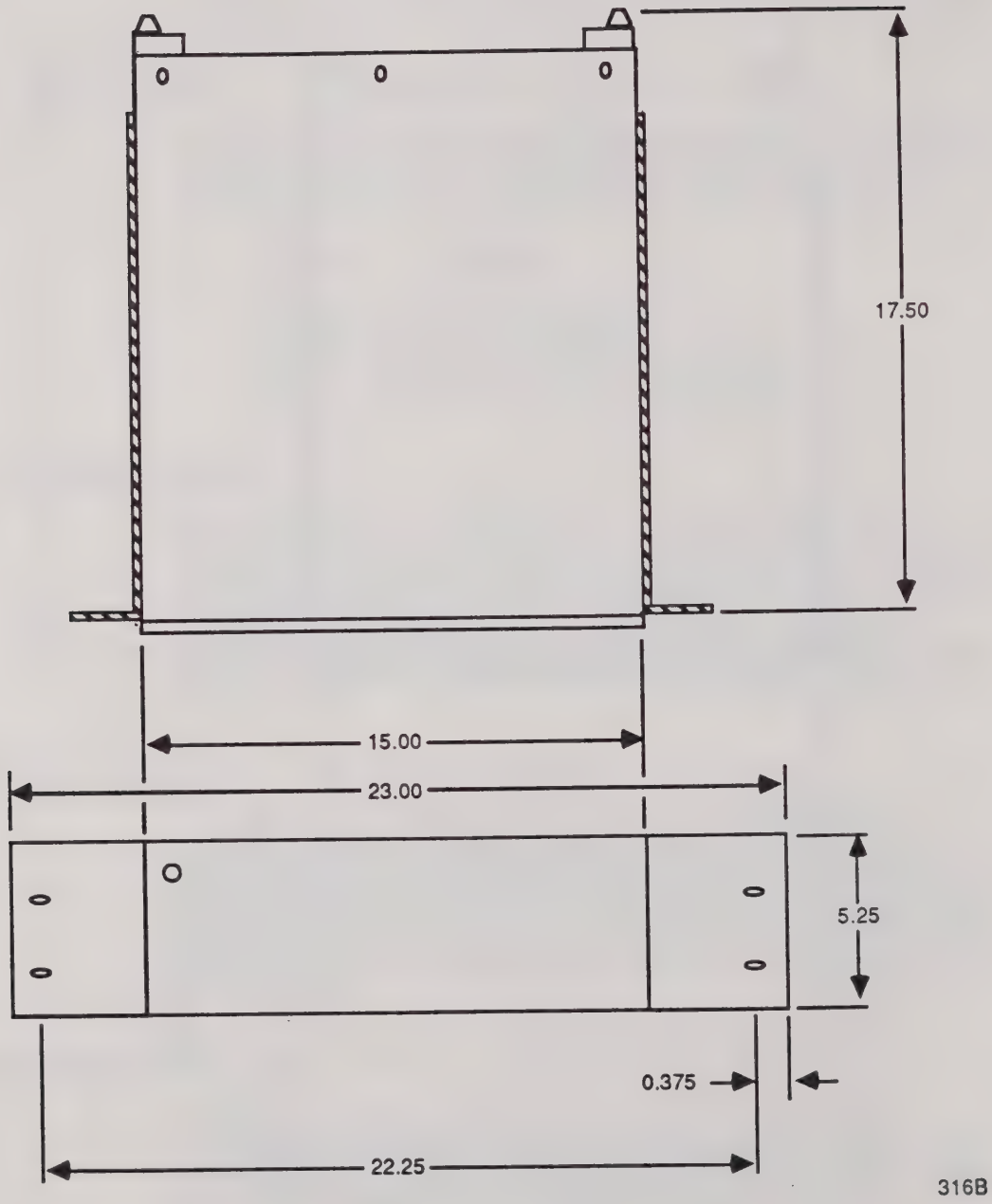


Figure 3-2. 23-Inch Rack, Flush-Mounting

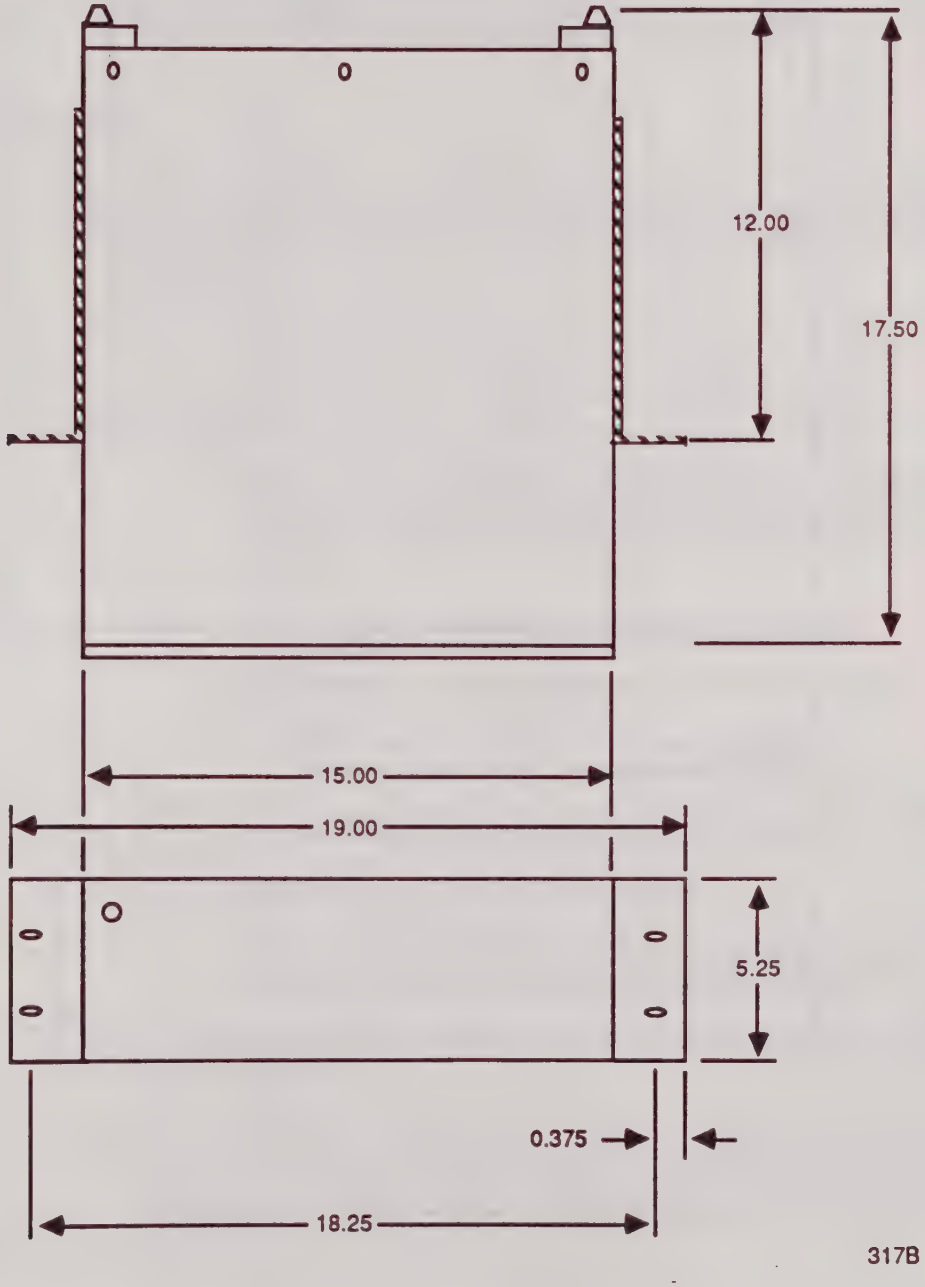


Figure 3-3. 19-Inch Rack, Forward Projection

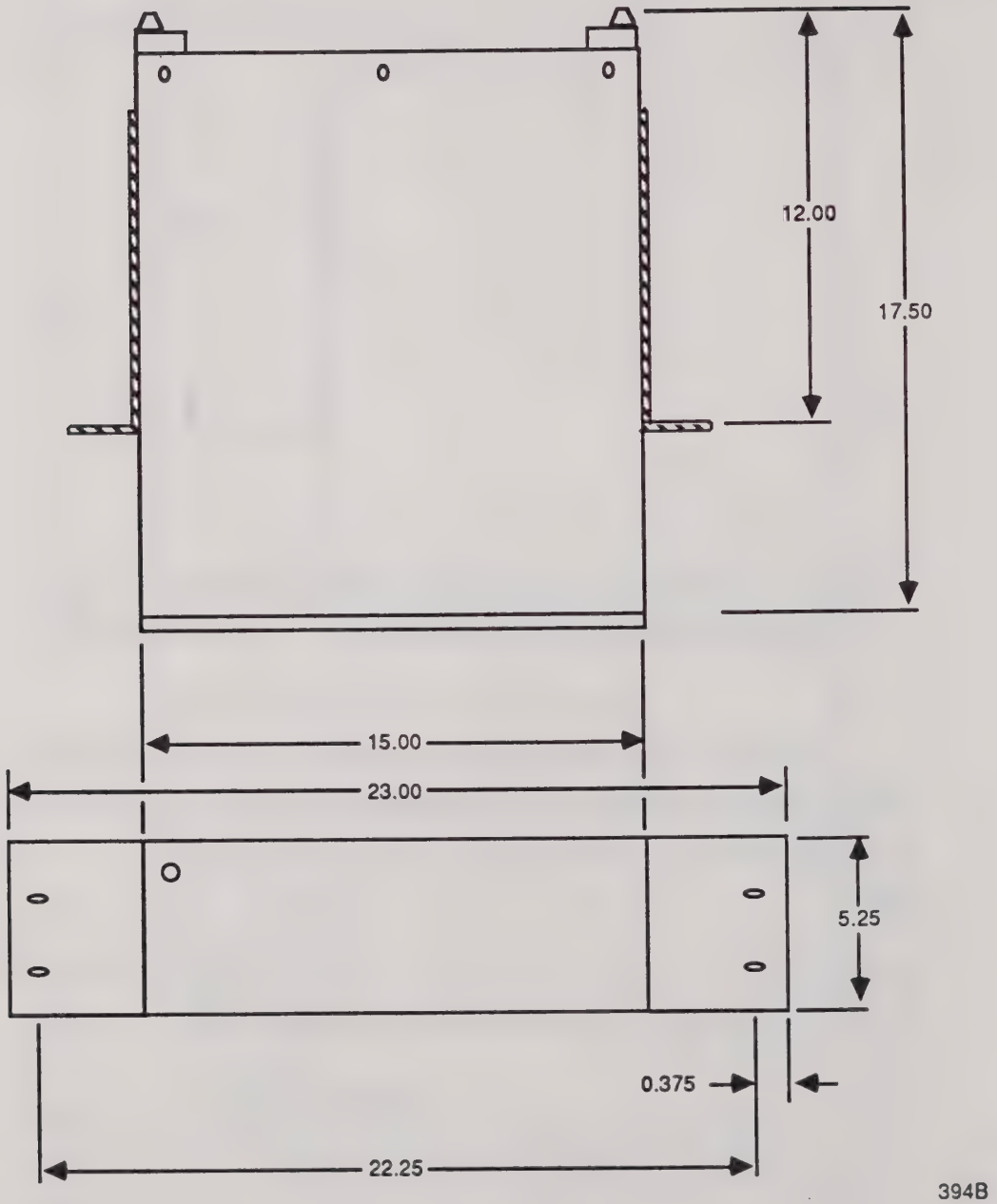


Figure 3-4. 23-Inch Rack, Forward Projection

3.2 Primary Power Connections

This section contains instructions for connecting primary ac or dc power to the CTS. The primary power requirements for the CTS can be determined by checking the information plate mounted on the right side of the rear panel.

3.2.1 AC Power Connection

For ac power operation, the CTS requires 105 to 130 Vac, or 210 to 260 Vac (switch-selectable) at line frequencies between 47 Hz and 63 Hz. A detachable, three-conductor ac power cord is supplied with the unit. To connect ac power to the CTS, perform the following:

STEP	CONNECTING AC POWER TO CTS
1	Before connecting the CTS power cord to an ac power source, check that the rear-panel ac line voltage selector switch is set for the available line voltage. (The location of the switch is shown in Figure 3-5.) To change the switch position: a) Remove the screw that secures the selector switch locking tab. b) Set the switch to the position that matches the available line voltage. *NOTE: When the switch is set to the correct position, the corresponding line voltage, either 115 or 230, appears on the switch.* c) Position the locking tab to secure the switch in position. d) Install the screw that secures the locking tab. e) Check that the installed fuse meets the fuse requirement stated on the CTS rear panel for the voltage selected. Replace the fuse if necessary.
2	Connect the ac power cord to the rear-panel ac power receptacle and to the ac power source. *NOTE: The ground conductor in the power cord grounds the chassis to the power line earth ground. If a two-conductor outlet is used with an adapter plug, connect the adapter wire to an appropriate ground.*

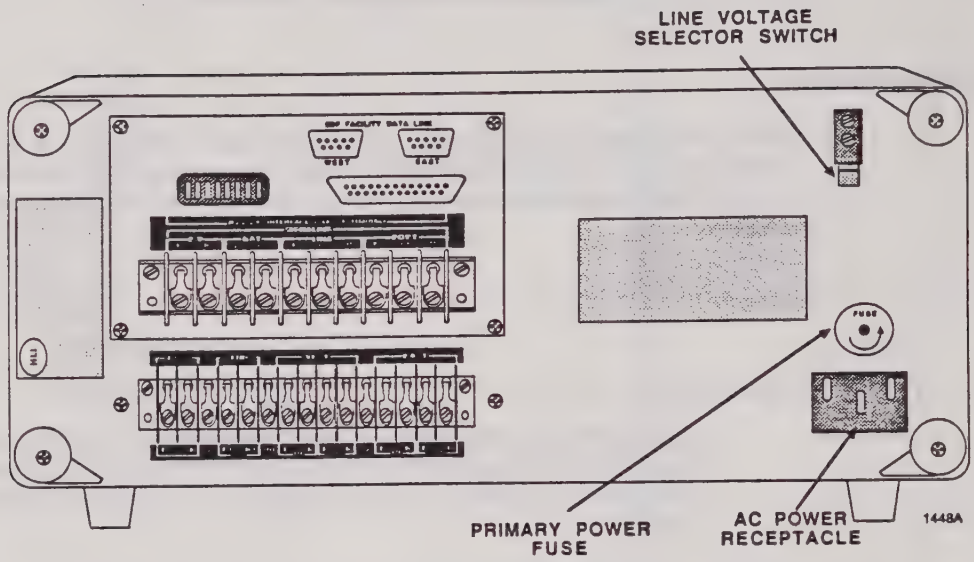


Figure 3-5. AC Power Receptacle, Line Voltage Selector Switch, and Fuse Locations

3.2.2 DC Power Connection

A CTS ordered with Option .06, -48 Vdc Operation, or Option .06A, -24 Vdc Operation, includes a rear-panel barrier strip for dc power connections. Use the following procedure to connect dc power to the unit.

STEP	CONNECTING DC POWER TO CTS
1	Before connecting the CTS to a dc power source, check that the installed fuse meets the fuse requirements stated on the CTS rear panel. Replace the fuse if necessary.
2	Connect the CHASSIS GND terminal, shown in Figure 3-6, to an appropriate ground.
3	Connect a dc power source (-48 or -24 Vdc, as applicable) to the -DC and BATTERY GND terminals shown in Figure 3-6.

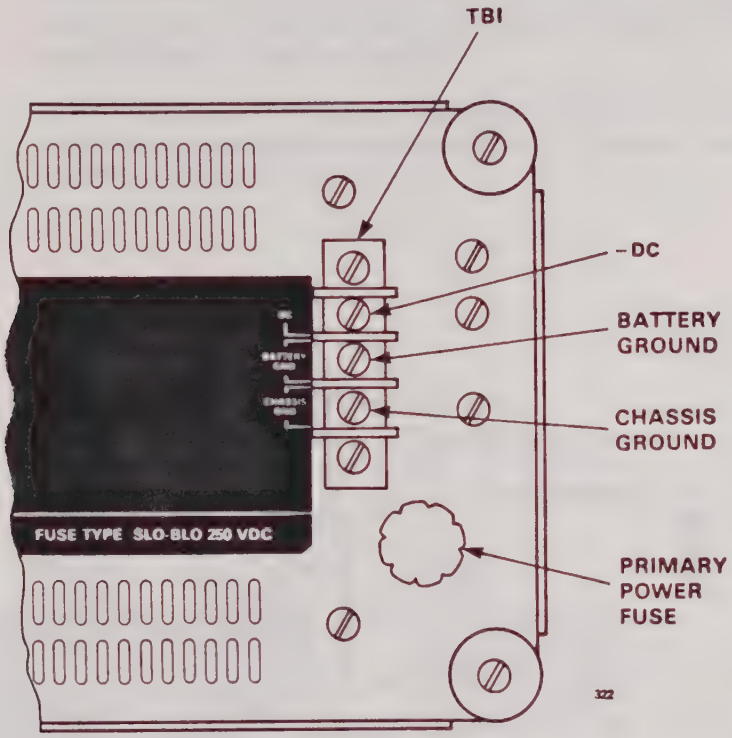


Figure 3-6. Terminals for DC Power Connection

3.3 Setup Instructions for Remote Control Operation

This section contains setup procedures for remote control operation. For this mode of operation, the CTS must include Option .25A-232 Remote Control (RS-232-C) or Option .25A-488 Remote Control (IEEE 488). Setup consists of connecting the interface connector on the CTS rear panel and setting applicable DIP switches. Separate instructions are available for the RS-232-C serial interface and the IEEE 488 interface versions of Option .25A Remote Control.

If the Remote Control option (Option .25A-232 or Option .25A-488) is field-installed in the CTS, the battery jumper located on the Remote Control PC Board should be placed in the OPERATE position. (See Figure 3-7). The factory-installed Option .25A is shipped in the OPERATE position and requires no action. When Option .25A-232 or Option .25A-488 is shipped separately from the CTS, the battery jumper is placed in the DISABLE mode.

To place the battery in the OPERATE mode, place the battery jumper over poles 2 and 3 of connector J34.

To place the battery in the DISABLE mode, place the battery jumper over poles 1 and 2 of connector J34.

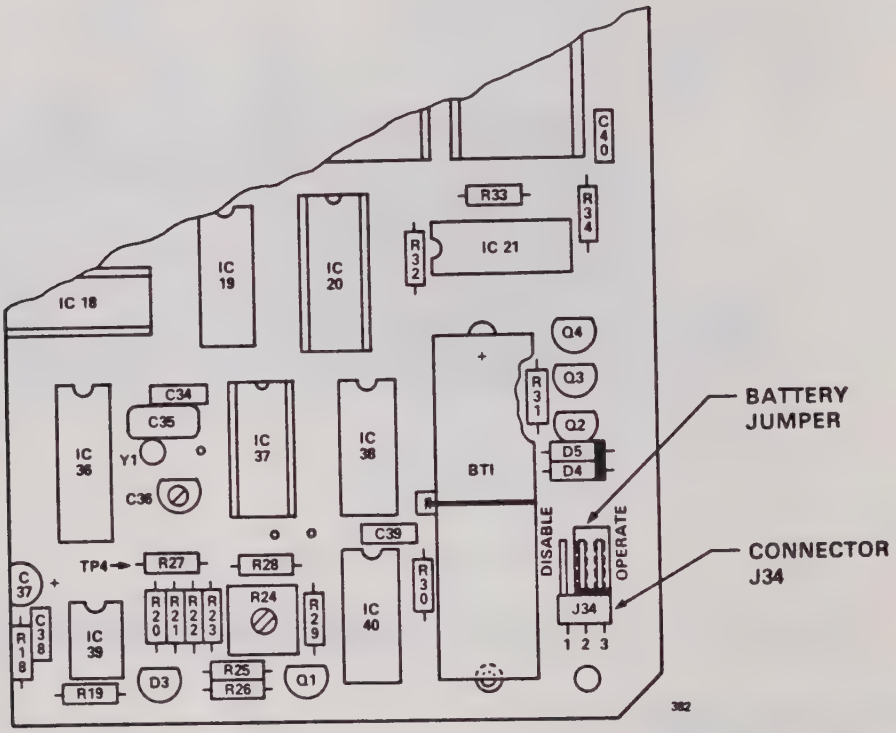


Figure 3-7. Battery Jumper Installation

3.3.1 Setup Instructions for RS-232-C/CCITT V.24 Serial Interface

The Option .25A-232 Remote Control (RS-232-C/CCITT V.24) interface allows control of the CTS with remote-located data terminals. Using full-duplex modems, such as a Bell System 103A or 212A, terminals can be connected over a voice-grade switched network or dedicated data channels. Data terminals can also be connected directly to the CTS. The Option .25A-232 RS-232-C interface is configured as DTE (data terminal equipment).

The RS-232-C interface transmits and receives data in a bit-serial and byte-serial asynchronous format. The character code used is the ASCII character set. The word length is selectable between 7 and 8 bits. Parity may be enabled and is selectable as odd or even. The number of stop bits may be selected as 1 or 2 bits.

The receive and send transmission rates are the same and are user-selectable from 110 through 9600 baud. Full-duplex transmission is used. Bell System 103A or 212A type, or other full-duplex modems may be used.

The RS-232-C INTERFACE connector and DIP switch are shown in Figure 3-8. Refer to the following paragraphs for instructions on setting the interface DIP switch and connecting data terminals to the connector.

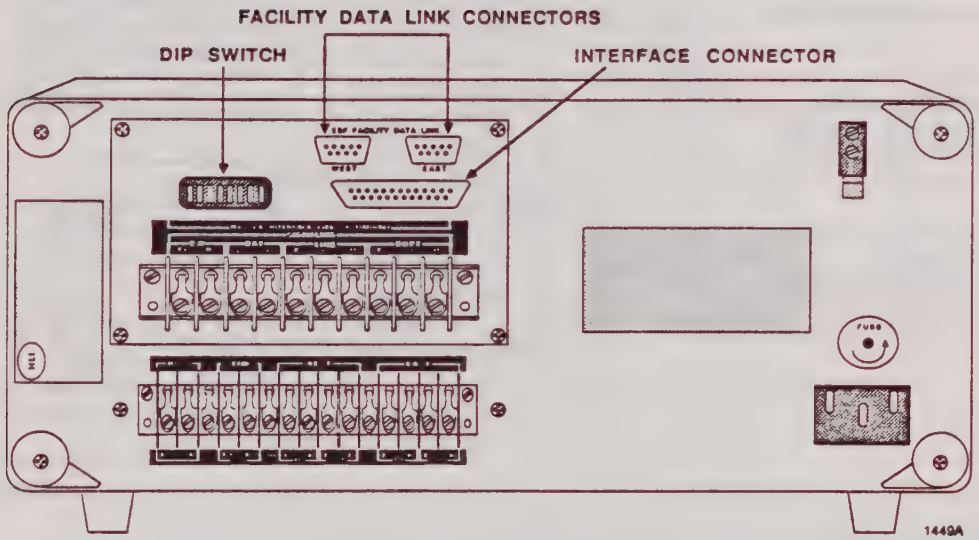


Figure 3-8. RS-232-C Interface DIP Switch and Connector

3.3.1.1 Setting the RS-232-C Interface DIP Switch

The operating mode, transmission rate, parity, and character length are selected through the RS-232-C INTERFACE DIP switch located behind the sliding cover on the rear panel. Refer to Figure 3-9 for switch settings to configure the unit to operate with the distant-end terminal equipment.

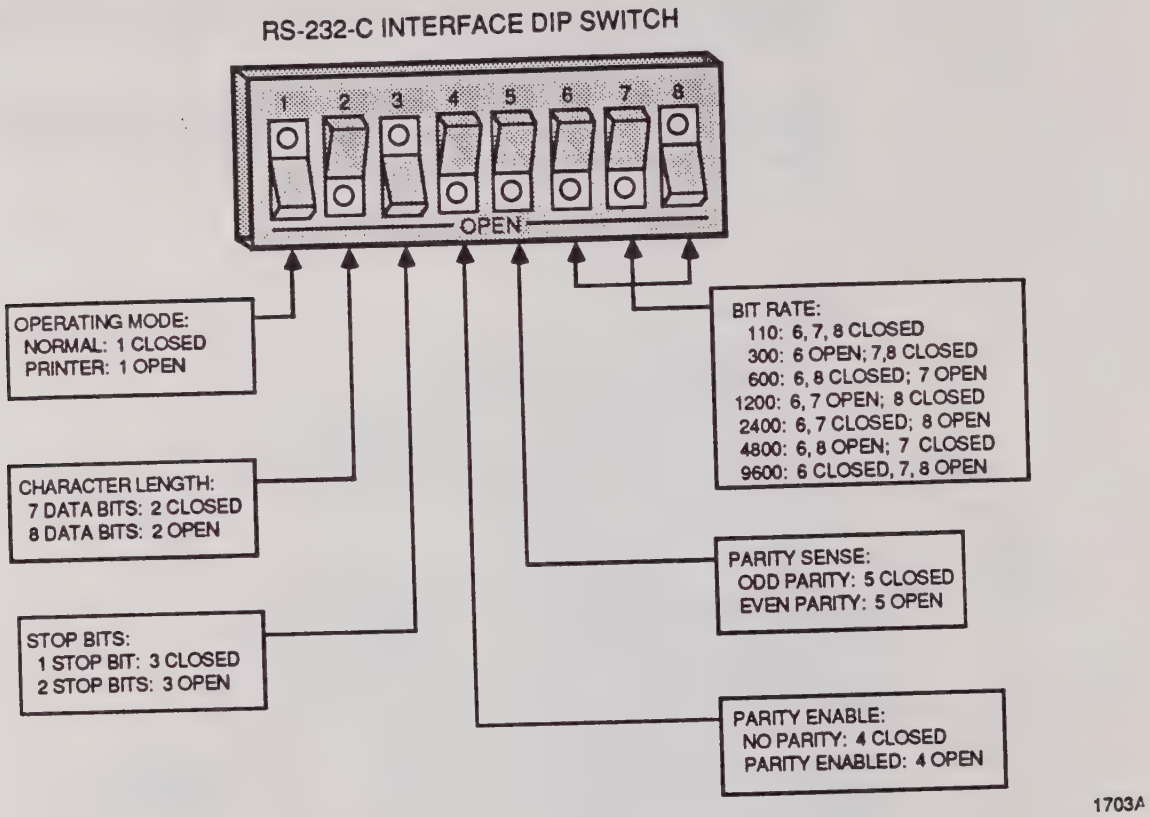

RS-232-C INTERFACE DIP SWITCH
1 2 3 4 5 6 7 8
OPEN
OPERATING MODE:
NORMAL: 1 CLOSED
PRINTER: 1 OPEN
CHARACTER LENGTH:
7 DATA BITS: 2 CLOSED
8 DATA BITS: 2 OPEN
STOP BITS:
1 STOP BIT: 3 CLOSED
2 STOP BITS: 3 OPEN
BIT RATE:
110: 6, 7, 8 CLOSED
300: 6 OPEN; 7,8 CLOSED
600: 6, 8 CLOSED; 7 OPEN
1200: 6, 7 OPEN; 8 CLOSED
2400: 6, 7 CLOSED; 8 OPEN
4800: 6, 8 OPEN; 7 CLOSED
9600: 6 CLOSED, 7, 8 OPEN
PARITY SENSE:
ODD PARITY: 5 CLOSED
EVEN PARITY: 5 OPEN
PARITY ENABLE:
NO PARITY: 4 CLOSED
PARITY ENABLED: 4 OPEN
1703A

Figure 3-9. RS-232-C Interface DIP Switch Settings

3.3.1.2 Connecting Devices to the RS-232-C Interface Connector

Control devices connect to Option .25A-232 Remote Control through the RS-232-C INTERFACE connector on the rear panel of the CTS. (A printer can be connected to this connector during front-panel operation. Refer to the setup instructions in paragraph 3.4 for more information.) RS-232-C INTERFACE connector pin assignments are given in Table 3-1. The required mating connector is an industry-standard, 25-pin, male DB-25P connector. Review the following guidelines for connecting devices to the RS-232-C INTERFACE connector:

- In order for the option to receive commands, the RS-232-C Data Set Ready and Receive Line Signal Detector lines must be true. For the option to send data, the RS-232-C Clear to Send line must also be true or tied to the Request to Send line.
- To interface the option to a modem, use a straight-through cable.

- To interface the option directly to a data terminal, the interconnecting cable must reverse pins 2 and 3 (Transmitted Data and Receive Data), tie pins 4 and 5 together (Request to Send and Clear to Send), and tie pins 6 and 8 (Data Set Ready and Receive Line Signal Detector) to true (such as pin 20, Data Terminal Ready).

TABLE 3-1. SERIAL INTERFACE CONNECTOR PIN ASSIGNMENTS

PIN	FUNCTION	DIRECTION
1	Frame Ground	----
2	Transmitted Data	Output
3	Received Data	Input
4	Request to Send	Output
5	Clear to Send	Input
6	Data Set Ready	Input
7	Signal Ground	----
8	Receive Line Signal Detector	Input
9-19	No Connection	
20	Data Terminal Ready	Output
21-25	No Connection	

3.3.2 Setup Instructions for IEEE 488 Interface

The Option .25A-488 Remote Control (IEEE 488) interface provides for talk and listen capabilities between the CTS and remote-located data terminals. Refer to the following paragraphs for instructions on setting the interface DIP switch and connecting data terminals to the connector.

Commands used to control the CTS are transmitted to the Option .25A-488 from a controller on the bus in a byte-serial, bit-parallel character format. Data or address information is transferred between devices, using the data bus lines (DI01-DI08). Handshake lines (NRFD, NDAC, and DAC) indicate the availability and validity of the information on the dat bus lines; if the devices are ready to accept data; and if the data has been accepted. Management lines (IFC, ATN, SRQ, REN, and EOI) specify whether the data bus lines are carrying data or address information (ATN); request service (SRQ); interface clear (IFC); and indicate the end of a transfer sequence (EOI). Other capabilities include:

- Source handshake (SHI)
- Acceptor handshake (AHI)
- Basic talker with serial poll (T6)
- Basic listener with serial poll (L4)
- Service request (SR1)
- Device clear (DC1)

3.3.2.1 Setting the IEEE 488 Interface Switches

The talk and listen addresses of the Option .25A-488 are the same. They are programmed with the eight-segment DIP switch on the rear panel of the CTS. For extended addresses, the eight-segment DIP switch is located on the edge of the Option .25A-488 PC board. Segment 1 of the rear-panel DIP switch sets the least significant bit of the binary-coded device address. Segment 5 sets the most significant bit. The extended address is similarly programmed using a DIP switch inside the unit. This requires removal of the top cover of the unit. (Refer to Section 6.) The rear-panel switch also allows selection of extended addressing and enabling of the SRQ function. (Refer to Table 3-2 and Figure 3-10.) The internal switch allows selection of send and receive termination characters. (Refer to Table 3-3 and Figure 3-11.)

TABLE 3-2. REAR-PANEL DIP SWITCH CONFIGURATION

SWITCH	DESCRIPTION
1	Talk/Listen Address Bit 1
2	Talk/Listen Address Bit 2
3	Talk/Listen Address Bit 3
4	Talk/Listen Address Bit 4
5	Talk/Listen Address Bit 5
6	Extended Address Enable
7	SRQ Enable on Data Available
8	Not Used
Note:	*Open: 1 = true, Closed: 0 = false*

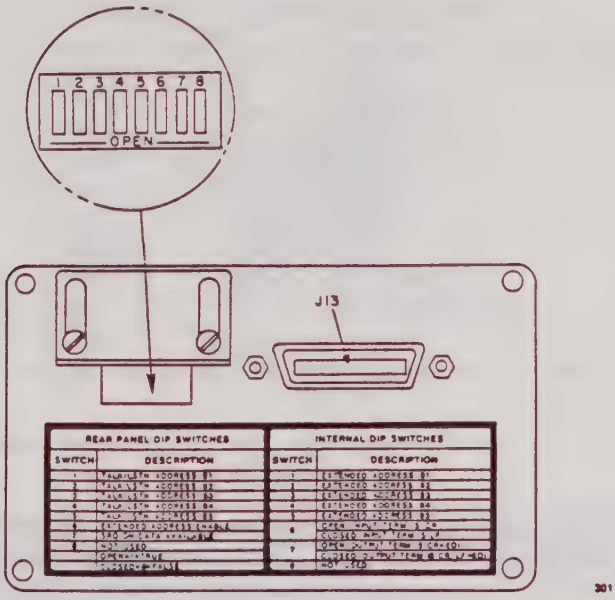


Figure 3-10. IEEE 488 Interface DIP Switch and Connector

TABLE 3-3. INTERNAL INTERFACE DIP SWITCH CONFIGURATION

SWITCH	DESCRIPTION
1	Extended Address Bit 1
2	Extended Address Bit 2
3	Extended Address Bit 3
4	Extended Address Bit 4
5	Extended Address Bit 5
6	Input Termination Character Open: CR or EOI Closed: LF or EOI
7	Output Terminations Character Open: CR + EOI Closed: CR LF + EOI
8	Not used Open: 1 = true Closed: 0 = false

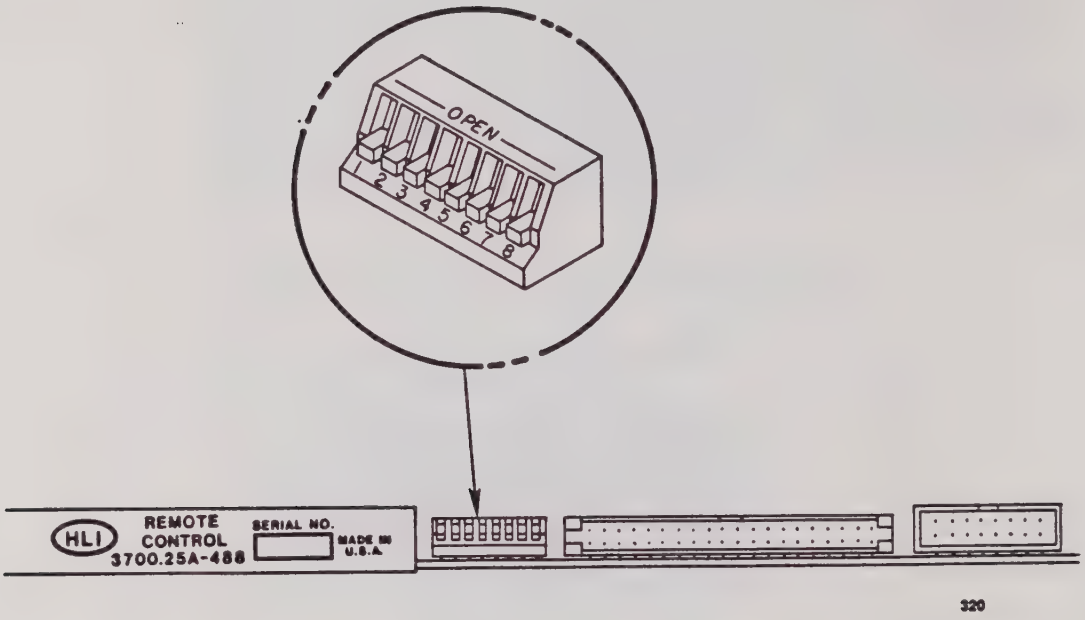


Figure 3-11. Internal Interface DIP Switch

3.3.2.2 Connecting Devices to the IEEE 488 Interface Connector

The standard interface connector is mounted on the rear panel of the CTS, and may be interconnected with up to 15 other devices simultaneously. The total bus length is 20 meters maximum, or 2 meters per device, whichever is less. The bus uses sixteen interconnection lines. These lines consist of 8 bidirectional data lines, 3 handshake lines, and 5 bus management lines. Refer to Table 3-4 for the IEEE 488 connector pin configuration.

TABLE 3-4. OPTION .25A-488 INTERFACE CONNECTOR PINS

PIN	FUNCTION	PIN	FUNCTION
1	DI01	11	ATN
2	DI02	12	SHIELD
3	DI03	13	DI05
4	DI04	14	DI06
5	EOI	15	DI07
6	DAC	16	DI08
7	NRFD	17	REN
8	NDAC	18-23	GROUND
9	IFC	24	GROUND, LOGIC
10	SRQ		

3.4 Setup Instructions for Printer Mode Operation

A CTS equipped with Option .25A-232 Remote Control (RS-232-C) can be operated in a printer mode during front-panel operation. With a serial interface printer connected to the RS-232-C INTERFACE connector on the rear panel, information displayed on the 40-character, front-panel display can be printed out.

Setup for the printer mode of operation consists of setting the RS-232-C INTERFACE DIP switch and connecting the printer. Refer to the instructions in paragraph 3.3 for setup information. Refer to Section 4 for operating instructions for printer-mode operation.

3.5 Line Under Test Connections

On the CTS, the line under test can be connected to front-panel bantam jacks or to barrier strip terminals on the rear panel. Refer to Section 2 for descriptions of the front and rear-panel test line connection components.

3.6 Facility Data Link Connections

A Model 3700-series basic unit equipped with Option .64 ESF PCM, provides access to monitor and drop-and-insert on the facility data link of extended superframed (ESF) T1 circuits. As shown in Figure 3-8, access is provided through two DB-9S connectors on the basic unit rear panel. The logic levels and polarities are RS-232-C compatible and configured as DCE. The pin assignments for the connectors are described in Table 3-5.

A labeled connector is provided on the rear panel for each direction, EAST and WEST. The actual direction of these connections varies with the mode of the ESF PCM option. Table 3-6 defines the directions for each mode (in-line, terminal, and DCS).

NOTE: The receive side monitors at all times, but the send side drops-and-inserts only upon selection in the in-line and DCS mode. The send side drop-and-inserts at all times in the terminal mode. In the DCS mode, only one connector is used since only one DS1 circuit is used.

TABLE 3-5. FACILITY DATA LINK CONNECTOR PIN ASSIGNMENTS

PIN	FUNCTION	DIRECTION
1	Protective Ground	----
2	Received Data	Output
3	Transmitted Data	Input
4	Receiver Signal Element Timing	Output
5	Transmission Signal Element Timing	Output
6	Not Used	
7	Signal Ground	----
8	Not Used	
9	Not Used	

TABLE 3-6. FACILITY DATA LINK CONNECTOR DIRECTION

CONNECTOR	IN-LINE MODE	TERMINAL MODE	DCS MODE
EAST	East-to-West	East	Not Used
WEST	West-to-East	West	DCS

SECTION 4 - MODEL 3705 FRONT PANEL-CONTROLLED OPERATION

CONTENTS PAGE

4.1 Introduction 4-6
4.2 Initial Startup and Checkout 4-6
4.2.1 Starting up the CTS 4-7
4.2.2 Digital Self-Test 4-7
4.2.3 Lamp Test 4-7
4.2.4 Displaying Software Revision Level 4-7
4.2.5 Displaying Installed Options 4-7
4.2.6 Real-Time Calendar/Clock Display 4-8
4.3 Printer and X-Y Recorder Outputs 4-8
4.3.1 Printer Output 4-8
4.3.2 X-Y Recorder Output (Option .07) 4-9
4.4 VF and PCM Line Interface 4-10
4.4.1 VF Line Interface 4-10
4.4.1.1 VF Line Impedance Selection 4-11
4.4.1.2 Bridge/Terminate Selection 4-12
4.4.1.3 Normal/Reverse Selection 4-12
4.4.1.4 Hold Control 4-12
4.4.2 PCM Line Interface 4-12
4.5 Dial/Talk Feature 4-17
4.5.1 VF Dial/Talk 4-17
4.5.1.1 2-wire Dial/Talk 4-18
4.5.1.2 2-wire Answer 4-19
4.5.1.3 4-wire Talk 4-20
4.5.2 VF Hold Control 4-20
4.5.3 PCM Dial/Talk 4-20
4.5.3.1 PCM Dial/Talk 4-21
4.5.3.2 Terminal Mode Analog Operation 4-25
4.5.3.3 FXS and FXO Foreign Exchange Signaling Sequences 4-27
FX Office Loop-Start (FXOLS) 4-28
FX Office Ground-Start (FXOGS) 4-29
FX Station Loop-Start (FXSLS) 4-29
FX Station Ground-Start (FXSGS) 4-30
4.5.4 VF Automatic Dial 4-30
4.5.5 DTMF/MF Signaling 4-32
4.5.6 Call Progress and Signaling (Option .35A and .35C) 4-33
4.5.6.1 Connections to Option .35A or .35C 4-34
4.5.6.2 Setup Procedures 4-35
4.5.6.3 Measurement Displays 4-36
4.5.6.4 Loop-Start Signaling 4-36
4.5.6.5 Ground-Start Signaling 4-37
4.5.6.6 E and M Signaling 4-38
4.5.6.7 SF Signaling 4-39

4.5.6.8 Address Signaling Detection 4-39
4.6 Signal Generator Setup 4-40
4.6.1 Generator Setup 4-40
4.6.2 Sweep Setup 4-41
4.7 VF Testing 4-42
4.7.1 Level-Frequency-S/N Measurements 4-42
4.7.1.1 Setup Procedure 4-44
4.7.1.2 Measurement Display 4-45
4.7.2 Noise Measurement 4-45
4.7.2.1 Setup Procedure 4-47
4.7.2.2 Measurement Display 4-48
4.7.3 Return Loss 4-48
4.7.3.1 Setup Procedure 4-49
4.7.3.2 4W Return Loss Measurement 4-51
4.7.3.3 2W Return Loss Measurement 4-52
4.7.3.4 Measurement Display 4-52
4.7.4 Impulse Noise Measurements 4-54
4.8 PCM Testing 4-54
4.8.1 Setup Instructions for PCM Testing 4-54
4.8.1.1 Operating Mode Selection 4-54
4.8.1.2 In-Line Mode Setup 4-55
Advanced In-Line PCM Setup Display 2 4-57
Advanced In-Line PCM Setup Display 3 4-58
4.8.1.3 Terminal Mode Setup 4-58
Terminal PCM Setup Display 2 4-59
Advanced Terminal Setup Display 2 4-60
Terminal PCM Setup Display 3 4-61
Advanced Terminal PCM Setup Display 3 4-62
4.8.1.4 DCS Mode Setup 4-62
DCS PCM Setup Display 2 4-63
Advanced DCS PCM Setup Display 2 4-64
4.8.2 Measurement Instructions 4-65
4.8.2.1 PCM Measurement Displays (In-Line and Terminal Modes) 4-65
PCM Performance Measurement Display 4-65
PCM Signaling and Control Measurement Display 4-66
4.8.2.2 PCM Measurement Displays (DCS Mode) 4-69
PCM Performance Measurement Displays (DCS Mode) 4-69
DCS PCM Signaling and Control Measurement Displays 4-70
4.9 Optional Tests 4-72
4.9.1 Transients (Option .11 and p/o .13) 4-72
4.9.1.1 Transients Setup Procedures 4-73
4.9.1.2 Impulse Noise Setup Procedures 4-74
4.9.1.3 Impulse Noise Measurement Display 4-75
4.9.1.4 Hits Setup Procedures 4-76
4.9.1.5 Hits Measurement Display 4-77
4.9.2 Envelope Delay (Option .12 and .12A) 4-77
4.9.2.1 Forward Reference Delay Measurement Description 4-78
4.9.2.2 Return Reference Delay Measurement Description 4-78
4.9.2.3 Envelope Delay Setup Procedures 4-79
4.9.2.4 Display of Envelope Delay Measurement Results 4-80
4.9.3 Jitter (p/o Option .13) 4-81
4.9.3.1 Jitter Setup Procedures 4-82

4.9.3.2 Jitter Measurement Display 4-82
4.9.4 Intermodulation Distortion (Option .14 and p/o .30) 4-83
4.9.4.1 Intermodulation Distortion Setup Procedures 4-84
4.9.4.2 Intermodulation Distortion Measurement Display 4-84
4.9.5 P/AR (Option .18, .18A, and p/o .30) 4-85
4.9.5.1 P/AR Setup Procedures 4-86
4.9.5.2 P/AR Measurement Display 4-87
4.9.6 VOM/CAP (Option .40) 4-87
4.9.6.1 VOM/CAP Setup Procedures 4-89
4.9.6.2 Voltage and Current Measurement 4-90
4.9.6.3 Resistance Measurement 4-91
4.9.6.4 Capacitance Measurement 4-92
4.9.7 Responder Interface Tests (Option .52) 4-94
4.9.7.1 Setup Procedures 4-96
4.9.7.2 105-Type Measurements 4-96
4.9.8 T1 Bit Error Ratio (Option .65) 4-98
4.9.8.1 Bit Error Ratio Setup Procedures 4-98
4.9.8.2 Entering a User-Defined Pattern 4-100
4.9.8.3 Error Injection Setup 4-100
4.9.8.4 Bit Error Ratio Measurement Displays 4-101
4.9.8.5 Frequency Difference Measurement 4-103
4.9.8.6 CSU/SMJ/RDL Loopback Display 4-104
4.9.8.7 Round Trip Delay Measurement Display 4-105
4.9.8.8 Sample Out-of Service Testing 4-106

FIGURES **PAGE**

4-1 Real-Time Calendar/Clock Display 4-8
4-2 Printer/X-Y Recorder Setup Display 4-9
4-3 VF Line Interface Setup Display 4-11
4-4 Typical In-Line PCM Test Connection 4-13
4-5 Typical Monitor PCM Test Connection 4-15
4-6 Typical Terminal PCM D-D Test Connection 4-15
4-7 Typical Terminal VF to PCM or PCM to VF Test Connection 4-16
4-8 Typical DCS Test Connection 4-16
4-9 VF Dial/Talk Setup Display (Without Option .35A or .35C) 4-17
4-10 PCM Dial/Talk Setup Display (With Option .35A or .35C) 4-24
4-11 PCM In-Line and Terminal Dial/Talk ABCD Bit Measurement Display 4-24
4-12 PCM In-Line and Terminal Dial/Talk SF Measurement Display 4-24
4-13 PCM DCS Dial/Talk Robbed-Bit Measurement Display 4-25
4-14 PCM DCS Dial/Talk SF Measurement Display 4-25
4-15 Terminal Mode Dial/Talk Typical Configuration 4-26
4-16 Typical PCM Foreign Exchange Testing 4-28
4-17 VF Automatic Dial Setup Display 4-31
4-18 DTMF Signaling Dial Display 4-33
4-19 MF Signaling Dial Display 4-33
4-20 Option .35A or .35C Barrier Strip Connections 4-34
4-21 VF Dial/Talk Setup Display (With Option .35A or .35C) 4-35
4-22 Loop-Start Measurement Display 4-36
4-23 Ground-Start Measurement Display 4-37
4-24 E and M Measurement Display 4-38
4-25 SF Measurement Display 4-39

4-26 Address Digit Receive Display 4-40
4-27 Send Setup Display 4-41
4-28 Sweep Setup Display 4-42
4-29 Level Setup Display 4-44
4-30 Level Measurement Display 4-44
4-31 Noise Setup Display 4-47
4-32 Noise Measurement Display 4-48
4-33 4W Return Loss Setup Display 4-49
4-34 2W Return Loss Setup Display 4-49
4-35 4W Return Loss Measurement Diagram 4-51
4-36 4W Return Loss Measurement Display 4-53
4-37 4W Sine Wave Return Loss Measurement Display 4-53
4-38 In-Line PCM Setup Display 4-55
4-39 In-Line PCM Setup Display 2 4-56
4-40 Advanced In-Line PCM Setup Display 2 4-57
4-41 Advanced In-Line PCM Setup Display 3 4-58
4-42 Terminal PCM Setup Display 2 4-59
4-43 Advanced Terminal PCM Setup Display 2 4-60
4-44 Terminal PCM Setup Display 3 4-61
4-45 Advanced Terminal PCM Setup Display 3 4-62
4-46 DCS PCM Setup Display 2 4-63
4-47 Advanced DCS PCM Setup Display 2 4-65
4-48 PCM Performance Measurement Display (In-Line or Terminal) 4-66
4-49 PCM Signaling and Control Measurement Display (ABCD Bit Signaling Version) 4-67
4-50 PCM Signaling and Control Measurement Display (SF Signaling Version) 4-68
4-51 DCS PCM Performance Measurement Display 4-70
4-52 DCS PCM Signaling and Control Display (Robbed-Bit Signaling Version) 4-70
4-53 DCS PCM Signaling and Control Display (SF Signaling Version) 4-72
4-54 Transients Setup Display 4-74
4-55 Three-Level Impulse Noise Setup Display 4-74
4-56 Impulse Noise Measurement Display 4-76
4-57 Hits Setup Display 4-76
4-58 Hits Measurement Display 4-77
4-59 Forward Reference Delay Measurement 4-78
4-60 Return Reference Delay Measurement 4-79
4-61 Envelope Delay Setup Display 4-80
4-62 Envelope Delay Measurement Displays 4-81
4-63 Phase Jitter Setup Display 4-82
4-64 Phase Jitter Measurement Display 4-83
4-65 Amplitude Jitter Measurement Display 4-83
4-66 Intermodulation Distortion Measurement Display 4-85
4-67 P/AR Setup Display 4-86
4-68 P/AR Measurement Display 4-87
4-69 Current Overload Display 4-89
4-70 VOM/CAP Setup Display 4-89
4-71 Volts dc Measurement Display 4-90
4-72 Volts ac Measurement Display 4-90
4-73 Milliamperes dc Measurement Display 4-91
4-74 Milliamperes ac Measurement Display 4-91
4-75 Resistance Measurement Display 4-92
4-76 Capacitance Measurement Display 4-93
4-77 Responder Interface Test Connections 4-95

4-78 Responder Interface Setup Display 4-96
4-79 Responder Interface Measurement Display 4-97
4-80 Bit Error Ratio Setup Display 1 4-99
4-81 User-Defined Pattern Setup Display 4-100
4-82 Bit Error Ratio Setup Display 2 4-100
4-83 Bit Error Ratio Measurement Display 1 4-102
4-84 Frequency Difference Measurement Display 4-103
4-85 CSU/SMJ/RDL Loopback Measurement Display 4-104
4-86 Round Trip Delay Measurement Display 4-105
4-87 Typical One-Way Loopback Test 4-106
4-88 Typical Office-to-Office Test 4-108

TABLES **PAGE**

4-1 X-Y Output Calibration Data 4-10
4-2 Intermodulation Distortion Measurement Correction Factors 4-84

4.1 Introduction

This section provides instructions for operating the Model 3705 Communications Test System (CTS) using front panel controls. Refer to Section 5 to operate the CTS from a remote location. Refer to Section 2 for the functions of the various front panel controls and indicators. The procedures contained in this section require that the CTS be installed and/or connected in accordance with the instructions given in Section 3. Initial startup and internal self-test procedures are given in Paragraph 4.2. VF and PCM line interface connections required prior to setup and measurement are given in Paragraph 4.4.

The CTS can be used to test both analog and digital circuits. It can perform in-service PCM error testing on digital T1 lines, as well as analog test functions on a digital channel. The CTS allows access to any of the 24 time slots that make up a DS-1 digroup. It is compatible with superframed D1D, D2, D3D4 channel banks, extended superframed (ESF), and SLC-96™ framing formats.

Bit-robbed A and B bit, ABCD bit, and SF signaling functions are provided. The test set can both detect and generate signaling supervision in both directions. It can also perform wink detection and signaling, bit robbed and SF pulsing, FXO or FXS signaling and control.

The CTS may be configured in any one of three test arrangements for PCM testing:

- INLINE for testing in-service circuits. Unselected channels are pass through undisturbed.
- TRML (terminal) for looped testing of channel banks. Idle channel code (01111111) is transmitted to unselected channels.
- DCS for testing channelized circuits through a test access digroup (TAD) on a Digital Cross-connect System (DCS). Unselected ports pass through undisturbed. (This permits daisy-chaining of multiple CTSs on a single DCS TAD.)

PCM error detection is performed in both directions on the TI line when in the INLINE or DCS arrangement. The CTS detects the following:

- Bipolar violations
- Excessive zeroes
- Frame bit errors
- CRC errors (ESF only)
- Multiframe bit errors (superframe only)
- Errored seconds

In addition to these tests: NO PCM, frame alignment, remote frame alignment alarms, and AIS (All 1s) are detected and displayed as they occur. With the use of the timer, the occurrences of the measurement conditions can be totalled for a period from 0.1 minutes to 100 hours.

4.2 Initial Startup and Checkout

This section describes how to startup and check out the CTS. It describes how to check the configuration (firmware level and options) and how to set the built-in calendar/clock.

4.2.1 Starting up the CTS

To start up the CTS, first ensure that primary power is properly applied to the CTS as described in Section 3, then press and release the POWER switch. Initially, the copyright screen is displayed while the digital self-test is performed. (The test takes about 10 seconds.) The VF line interface setup display appears if the unit passes the self-test. If it fails the test, an error code is displayed. Refer to Paragraph 4.2.2 for additional information about error codes.

4.2.2 Digital Self-Test

At power-up the CTS performs an extensive digital test of its memory functions. The test runs for about 10 seconds before the VF line interface setup display appears. If an error is detected during the self-test and the CTS is still functional, an error code appears on the display. When the error code is displayed, the CTS holds for about seven seconds and then re-initializes the self-test sequence.

The error code format is as follows:

```
E<XXYY>
```

where XX = error type in hexadecimal; YY = address in hexadecimal. Refer to Section 6, Maintenance for more information about error codes.

4.2.3 Lamp Test

To perform a lamp test, press the LINE key and then the "3" key on the keypad. All key-switch LEDs light, and fill the 40-character display for three seconds.

4.2.4 Displaying Software Revision Level

To display the software designation, press the LINE key and then the "1" key on the keypad. The display presents the following format:

```
HLI 3705 REV F15.05 or
HLI 3705 REV D15.05 (Option .10)
```

4.2.5 Displaying Installed Options

To display the options installed in the CTS, press the LINE key and then the "2" key on the keypad. The description of each installed option appears sequentially on the display for one second.

Note: Option .08 (four impedance VF I/O), Option .09 (20 kHz operation), Option .11 (three-level impulse noise), Option .16 (return loss), and Option .60 (DTMF and MF Signaling) are standard with Revision 12 or greater firmware.

4.2.6 Real-Time Calendar/Clock Display

If Remote Control Option .25A is installed, pressing the LINE key and then the "5" key on the keypad causes the real-time calendar/clock display to appear. The display shows month/day/year and then hour:minute:second. Pressing the first soft key allows you to enter the month and day via the keypad. The second soft key allows you enter the year. The third and fourth soft keys allow you to enter the hour, minute, and second via the keypad. (Refer to Figure 4-1). The clock is powered by a lithium battery on the Option .25A board, and continues to run when primary power is removed from the unit.

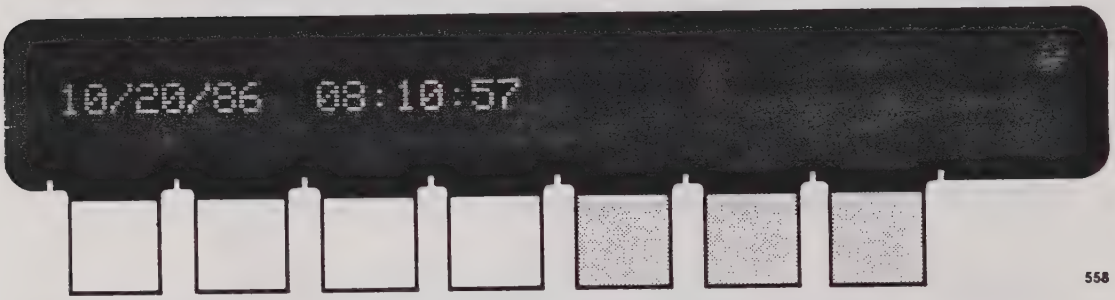


Figure 4-1. Real-Time Calendar/Clock Display

4.3 Printer and X-Y Recorder Outputs

This section describes how to use a printer to print displays and how to use an X-Y recorder to graph test results. (To connect an X-Y recorder, the CTS must include Option .07, X-Y Outputs.)

4.3.1 Printer Output

For printer-mode operation, Option .25A-232 Remote Control must be installed. In this mode of operation, the information displayed on the front panel alphanumeric display can be routed to a serial printer connected to connector RS-232-C INTERFACE. All RS-232-C lines must be connected and the rear panel DIP switches configured according to the instructions in Section 3, Installation.

> *NOTE: The DIP switch settings are encoded when the unit is first turned on. Therefore, if the switch positions are changed with the unit turned on, the unit must be turned off and then on again to encode the new switch settings.*

Perform the following steps to operate the unit in the printer mode:

STEP	OPERATING CTS IN PRINTER MODE
1	Set the POWER switch on the front panel to turn off the unit.
2	Connect the printer to connector RS-232-C INTERFACE on the rear panel.
3	On the rear panel, set RS-232-C INTERFACE position 1 to OPEN.
4	Press the POWER switch on the front panel to turn on the unit. After a 10-second delay, the line display characters appear.
5	Press the "4" key on the ENTER keypad. The display shown in Figure 4-2 appears.
6	To select the printer mode, press the second soft key located below the OFF characters shown in Figure 4-2. The OFF characters are replaced by ON, indicating that the unit is in the printer mode of operation. During all operations except dial/talk, press the "+" key on the ENTER keypad to print the displayed characters. *NOTE: When performing dial/talk operations, the "+" key is the offhook control.*

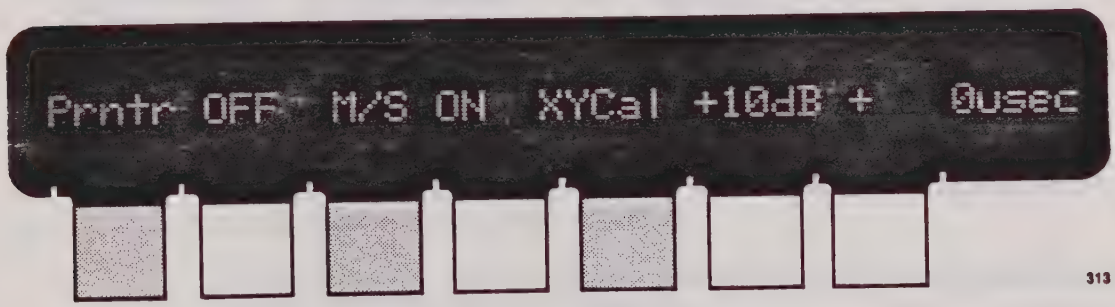


Figure 4-2. Printer/X-Y Recorder Setup Display

4.3.2 X-Y Recorder Output (Option .07)

X-Y Outputs Option .07 generates signals for the plotting of level, or delay versus frequency. The rear-panel barrier strip on the CTS contains terminals labeled GND, DB, DELAY, and FREQ that are used when connecting a voltage-driven plotter or X-Y recorder to the CTS. The barrier strip terminal labeled AJ/PJ allows external monitoring of demodulated amplitude jitter or phase jitter. Refer to Section 2, Table 2-4 for Option .07 specifications.

To calibrate a plotter, press the LINE key and then the "4" key on the keypad. Soft keys are used for level and delay calibration of the plotter over the following ranges:

- +10 to -40 dBm for level measurements
- -9999 to +9999 µsec for group delay measurements
- -3000 to +9999 µsec for envelope delay measurements

The frequency output range is determined by the low and high limit sweep frequencies set during the sweep setup. The low sweep limit frequency corresponds to an output of 0 Vdc and the high sweep limit corresponds to a +5.00 Vdc output, provided the frequency sweep range is greater than or equal to 256 Hz. Once the sweep limits are set, any point between the limits can be produced by looping the RCV and SEND (2W) jacks and readjusting the SEND display for the desired frequency. The output voltages for the limits and nominal cases are listed in Table 4-1.

TABLE 4-1. X-Y OUTPUT CALIBRATION DATA

Terminal	Measurement	Measured Value	Output (VDC)
DB	Level	-40 dBm	-4.00
		0 dBm	0.00
		+10 dBm	+1.00
DELAY	Group Delay (Option .17)	-9999 µsec	-5.00
		0 µsec	0.00
		+9999 µsec	+5.00
DELAY	Envelope Delay (Option .12)	-3000 µsec	-1.50
		0 µsec	0.00
		+9000 µsec	+4.50
FREQ	All	low sweep limit	0.00
		high sweep limit	+5.00

4.4 VF and PCM Line Interface

4.4.1 VF Line Interface

CAUTION: The CTS, except as defined in the specifications, it is not designed to withstand long duration, high voltage, low impedance ac and dc sources. Application of levels in excess of normal measurement range (+10 dBm) may result in damage to the unit.

This section describes the VF line interface connections required to perform VF circuit measurements. The CTS has two sets of VF balanced terminals and is capable of sending and receiving signals simultaneously. The operator can connect to the CTS through either front panel bantam-type jacks or the rear panel barrier strip connector. When using the DIAL/TALK bantam jack, be sure to use a bantam-type plug or equivalent. Use of any other type of plug can damage the contacts of the bantam jack.

The lower left portion of the front panel, labeled VF TEST LINES, contains the bantam jacks for the lines under test, the bantam jack for an external handset, and the function switches for line interface and dial/talk. The CTS has internal dial/talk capability and requires no external handset, although a connector for one is provided.

The LINE key is used for making line interface selections. These selections include impedance, bridge/terminate, line reversal, and hold control. The LINE key may be activated at any time during a measurement to verify the test conditions. The line interface selections may be made at any time except during the timed portion of an integrating measurement such as hits or impulse noise.

4.4.1.1 VF Line Impedance Selection

The CTS provides four commonly-used terminating impedances. Independently set send and receive impedances of 135 ohms, 600 ohms, 900 ohms, and 1200 ohms are provided. All impedance settings are dc blocked, except for 135 ohms. Failure to select the proper impedances causes errors in both send and receive levels. The VF line interface setup display is shown in Figure 4-3.

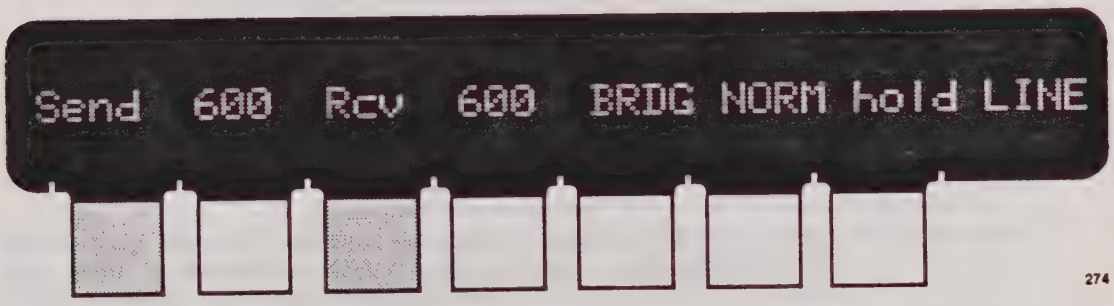


Figure 4-3. VF Line Interface Setup Display

To select the send side line impedance, press the soft key just to the right of the Send label. Selections are 600, 900, 1200, and 135.

To select the receive side line impedance, press the soft key just to the right of the Rcv label. Selections are 600, 900, 1200, and 135.

If the LINE key is pressed while 2W operation is selected in return loss or responder interface, the VF line interface setup display shows 2W and the selected impedance. The soft keys are disabled.

4.4.1.2 Bridge/Terminate Selection

When the CTS is bridged across a receive line, the receive levels refer to the selected terminating impedance.

To select a bridging measurement on the receive line, press the soft key under TERM. BRDG appears.

To select the test set's internal termination on the receive line, press the soft key under BRDG. TERM appears.

4.4.1.3 Normal/Reverse Selection

The normal/reverse selection enables the function of the send/receive jacks to be interchanged and may be used in 2-wire (2W) or 4-wire (4W) operation.

To select normal line connection, press the soft key under REV. NORM appears. Normal 4W line connection is talk on the NORM-SEND (2W) jack, and listen on the NORM-RCV jack. Normal 2W connection is talk/listen on the NORM-SEND (2W) jack.

To select reverse line connection, press the soft key under NORM. REV appears. Reverse 4W line connection is talk on the NORM-RCV jack, and listen on the NORM-SEND (2W) jack.

4.4.1.4 Hold Control

To activate the hold function, press the soft key under hold. Uppercase letters indicate that it is active. Pressing the soft key again toggles the hold function off. Hold circuits are provided for both the NORM-SEND (2W) jack and the NORM-RCV jack. They are controlled together by the HOLD function except during dial/talk. If dial/talk is active, then the hold circuit for the selected jack is controlled by the "+" and "-" keys on the keypad, or by the hook switch on the external handset if it is installed in the DIAL/TALK jacks. The selected line is the NORM-SEND (2W) jack for the NORM selection, and the NORM-RCV jack for the REV selection. During dial/talk, the jack not selected is always controlled by the HOLD function.

4.4.2 PCM Line Interface

The CTS provides a 4-wire interface for the connection to the T1 line. Four separate bantam jacks are available to connect the transmit (output) and receive (input) pairs from both directions on the T1 line. This makes it possible to connect the unit in series with the T1 line for full-duplex, in-line testing. In this arrangement the DS-1 signal passes through the unit, allowing performance monitoring of the in-service T1 lines. Figure 4-4 is a simplified diagram showing the CTS in this arrangement.

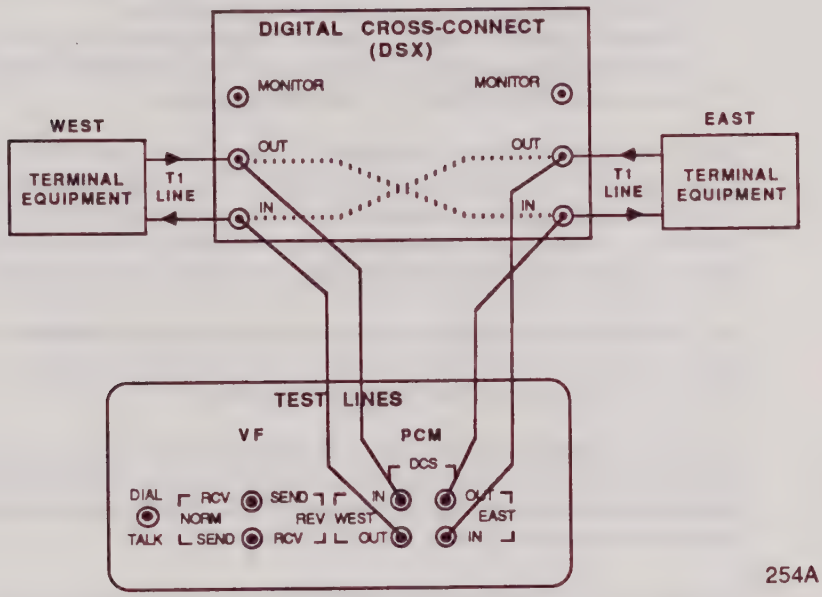


Figure 4-4. Typical In-Line PCM Test Connection

NOTE: The terminals in Figure 4-4 are designated east and west. These are the traditional reference designations for terminals in carrier systems. In these systems, circuits were designated as either west-to-east or east-to-west, depending on the direction of transmission.

Although the east and west designations are traditional, the direction of transmission on your T1 lines might not be identified in this manner. If not, you need to determine which equipment you want to designate as east and which as west.

Since the CTS makes a bidirectional connection to the T1 line, the EAST and WEST labels on the front panel serve to identify the direction of test. These labels cross-reference to the direction of transmission on the T1 line.

Looking again at Figure 4-4, a PCM test to the CTS WEST direction checks the signal at the cross-connect OUT jack from the west terminal equipment. In the EAST direction, the signal at the east terminal equipment cross-connect OUT jack is checked.

The following important factors should be considered when connecting the CTS to the T1 line:

- The CTS PCM line connection consists of two matched 100 ohm balanced 4-wire interfaces. The interface labeled WEST is a functionally-identical match to the interface labeled EAST. The IN jacks may be selected for 100 Ohms (TERM) or >1000 Ohms (BRDG).

- The EAST and WEST designations on the CTS are only for your reference. They identify the direction of the PCM test results shown on the display. The results are obtained from the output or transmit pair of the equipment connected to the module IN jack, which corresponds to the selected test direction.
- There are four different ways you can connect the test system to the T1 line. The connection you use depends on the type of testing you want to conduct. (The connections are described in the following paragraphs.)

Monitor Jack Access - used where there is a monitor jack to access the T1 line. If you want to check for PCM fault conditions and do not want to make an analog test access to a specific channel, you can connect the CTS to the T1 line via the monitor jack (see Figure 4-5). You may watch the signaling bits work, and listen, but not talk, on the VF channel. The PCM IN jacks may be bridged or terminated for this configuration.

In-Line Series Access - used when you want to check the PCM performance of an in-service T1 line and also conduct drop-and-insert analog testing on specific channels. The PCM In jacks must be terminated for this configuration.

Looped or Terminal Mode Access - used in tests where the T1 line is not in active service, so there is no concern about disrupting traffic on the circuits. The CTS is used as a terminal or channel bank in this testing mode. The PCM IN jacks must be terminated for this configuration.

DCS Mode - used when connecting to the TAD of a DCS, but only when the WEST OUT and EAST IN jacks are empty. Permits monitoring of a channel mapped down to the DCS test port. Also allows drop-and-insert testing on this channel if the channel is split. The PCM IN jacks must be terminated for this configuration. Up to 12 CTSs may be daisy-chained on one DCS TAD, with each set to a separate test port and performing independent channelized testing.

Figures 4-6, 4-7, and 4-8 illustrate other typical test connections.

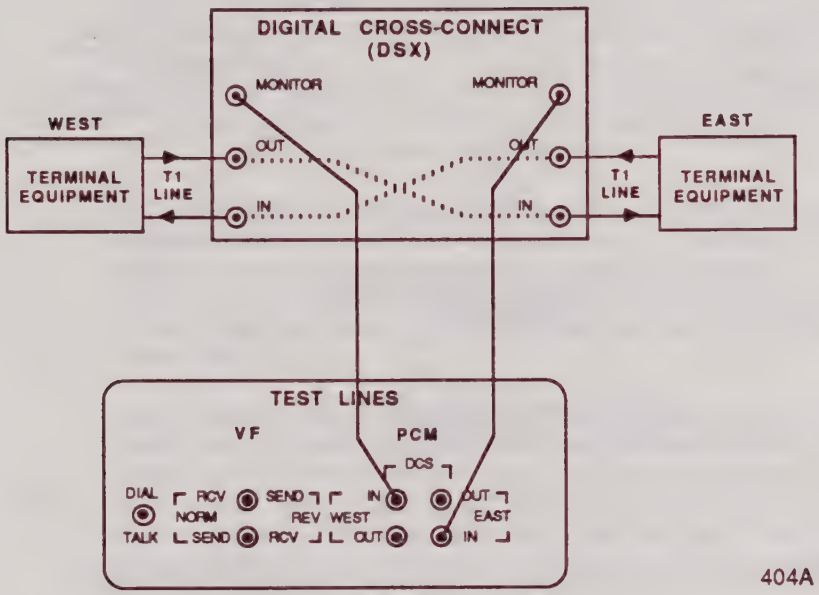


Figure 4-5. Typical Monitor PCM Test Connection

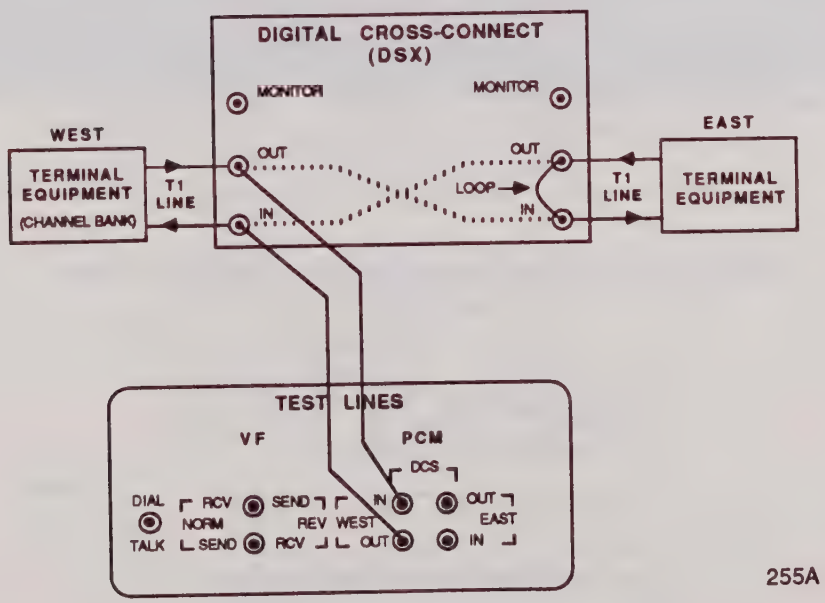


Figure 4-6. Typical Terminal PCM D-D Test Connection

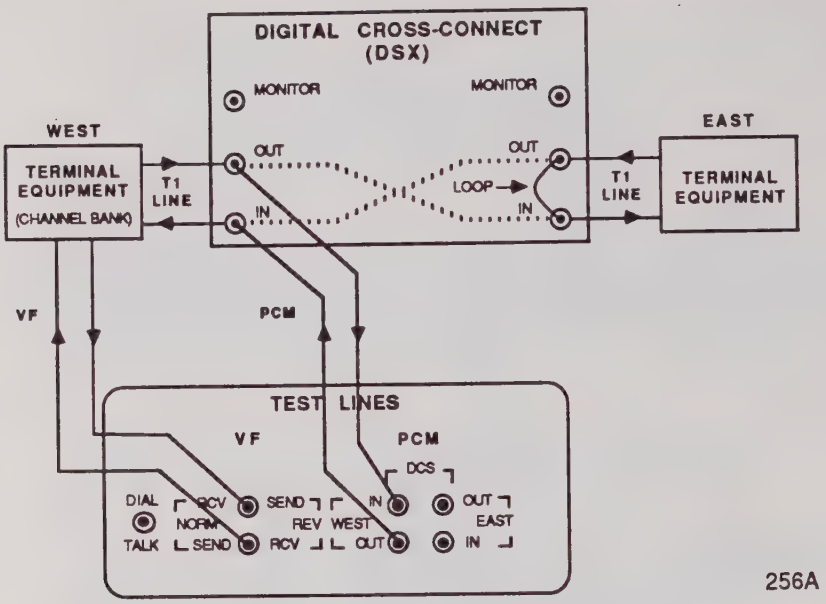
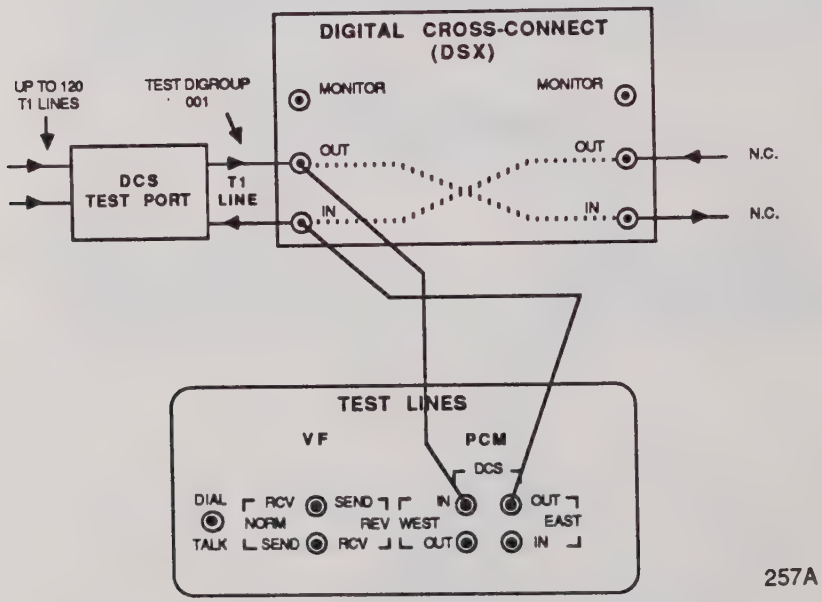


Figure 4-7. Typical Terminal VF to PCM or PCM to VF Test Connection



NOTE: WEST OUT AND EAST IN JACKS MUST BE EMPTY.

Figure 4-8. Typical DCS Test Connection

4.5 Dial/Talk Feature

The CTS offers VF dial/talk, VF hold control, PCM dial/talk, VF automatic dial, DTMF/MF signaling, and call progress and signaling capabilities. The following paragraphs discuss each of the capabilities. Procedures for using each of the capabilities are also included.

4.5.1 VF Dial/Talk

The DIAL/TALK key is used to initiate a connection by pulse dialing on a 2W line, or to communicate on a 4W line. The 2-wire connection is accomplished by using the ENTER keypad or by using an external handset in the DIAL/TALK bantam jack. The MONITOR section of the front panel is used to activate the Talk function, perform the speaker/microphone function, and adjust the listening level. Refer to Figure 4-9 for dial/talk operation.

The CTS without options is equipped to perform loop-start signaling on 2-wire wet circuits, or to disconnect the hold function for use on dry circuits which require no supervision. To disconnect the hold circuits, press the soft key under LPST (loop-start). NONE appears. With NONE selected, HOLD no longer appears in the LINE and TALK displays, and DPS is no longer available as a dialing selection. If the Call Progress and Signaling Option (Option .35A or .35C) is installed, a CP appears over the second soft key in Figure 4-9.

Figure 4-9. VF Dial/Talk Setup Display (Without Option .35A or .35C)

4.5.1.1 2-wire Dial/Talk

Perform the following procedure to dial and talk on a 2-wire circuit:

STEP	PERFORMING 2-WIRE DIAL/TALK
1	Press the DIAL/TALK key to activate the dial/talk display.
2	To dial and talk on a 2W line, press the soft key under 4W. 2W appears.
3	Verify that the hold function is in the proper mode. Lowercase letters indicate that the hold function is inactive. Refer to Paragraph 4.5.2.
	NOTE: If an external handset is to be used, go to Step 9.
4	Connect the 2W line to the VF NORM-SEND (2W) jack. Press the "+" key on the ENTER keypad and listen for a dial tone on the MONITOR speaker.
5	Enter the number to be dialed through the ENTER keypad.
6	Once the connection is made, the TO/FROM/TALK switch is depressed to talk, and released to listen. The MONITOR control can be set to a comfortable listening level. To talk, speak into the MONITOR speaker.
7	To maintain the connection during measurements, the hold function must be activated before leaving the dial/talk display.
8	If it is necessary to redial, press the "-" key on the ENTER keypad to drop the line, then press the "+" key and listen for a dial tone before dialing.
9	If an external handset is used, connect the handset to the DIAL/TALK bantam jack.
10	Use the switch hook control on the handset to go offhook.
11	Once dial tone is received, use the handset to enter the number to be dialed.
12	To maintain the connection during measurements, the hold function must be activated before leaving the dial/talk display.

4.5.1.2 2-wire Answer

Perform the following procedure to answer on a 2-wire circuit:

CAUTION: Application of incoming ring voltage to the CTS VF TEST LINES may cause permanent damage to the test set. Do not allow incoming ring to be applied to the RCV or DIAL/TALK jacks. Do not allow incoming ring to be applied to the SEND jack unless dial/talk is active and on-hook has been selected.

STEP	PERFORMING 2-WIRE ANSWER
1	Press the DIAL/TALK key to activate the dial/talk display.
2	To answer on a 2W line, first press the soft key under 4W. 2W appears.
3	Verify that the hold function is in the proper mode for the line not selected. Lowercase letters indicate that the hold function is inactive. Refer to Paragraph 4.5.2.
	NOTE: If an external handset is used, go to Step 7.
4	Press the "-" key to place the selected line on-hook. This is the only safe condition in which to receive incoming ring voltage. Connect the 2W line to the VF NORM-SEND (2W) jack. Listen for the incoming ring signal on the MONITOR speaker.
5	Answer the incoming call by pressing the "+" key on the ENTER keypad. Adjust the MONITOR control for a comfortable listening level.
6	To maintain the connection during measurements, the hold function must be activated before leaving the dial/talk display. Do not apply incoming ring after leaving the dial/talk display.
7	If an external handset is used, verify that the handset hook switch is in the monitor or on-hook condition before connecting the handset to the DIAL/TALK bantam jack.
8	With the CTS is in the dial/talk display, listen on the handset or MONITOR speaker for the incoming ring signal.
9	Answer using the hook switch on the handset.
10	To maintain the connection during measurements, the hold function must be activated before leaving the dial/talk display. Do not apply incoming ring after leaving the dial/talk display.

4.5.1.3 4-wire Talk

Perform the following procedure to talk on a 4-wire circuit:

STEP	PERFORMING 4-WIRE TALK
1	Press the DIAL/TALK key to activate the dial/talk display.
2	To talk on a 4W line, press the soft key under 2W. 4W appears.
3	Verify that the hold function is off by observing hold in lowercase letters. If necessary, press the soft key under HOLD to toggle it off.
4	Connect the send line to the VF NORM-SEND (2W) jack and connect the receive line to VF NORM-REC jack. *NOTE: If an external handset is used, go to Step 7.*
5	To talk, depress the TO/FROM/TALK switch to TALK, and speak into the MONITOR speaker.
6	To listen, release the TO/FROM/TALK switch, and adjust the MONITOR control for a comfortable listening level.
7	If an external handset is used, connect the handset to the DIAL/TALK bantam jack. The handset can now be used to talk and listen.

4.5.2 VF Hold Control

To activate the hold function, press the soft key beneath hold. During dial/talk, the hold circuit for the selected line in the 2-wire mode is controlled by the "+" and "-" keys on the keypad, or by the hook switch on the external handset if it is installed.

The hold circuit for the line which is not selected is controlled directly by the hold function. Once out of dial/talk, such as during a measurement, both hold circuits are controlled by the hold selection. HOLD is in uppercase letters when active; pressing the soft key again toggles it off. The hold function is not available if NONE is selected for the signaling method in the talk display.

4.5.3 PCM Dial/Talk

The CTS provides the same dial/talk capabilities on a PCM channel as it does on the VF line. In addition, it performs SF detection and generation, and FXS and FXO signaling and control functions.

4.5.3.1 PCM Dial/Talk

Perform the following procedure to dial/talk on a PCM channel:

STEP	PERFORMING PCM DIAL/TALK
1	Press the PCM key, then press the soft key under "on". The PCM LED lights.
2	Press the DIAL/TALK key. The PCM dial/talk setup display (Figure 4-10) appears.
3	Press the first soft key to select dial pulse (DPS), DTMF or MF dialing.
4	Press the third key to select the type of signaling protocol, either normal (NORM), FX office loop-start (FXOLS), FX office ground-start (FXOGS), FX station loop-start (FXSLS), or FX station ground-start (FXSGS). Select NORM.
5	Use the fourth soft key to enable wink detection (WNKD) or no wink detection (NOWD).
6	Use the fifth soft key to select bit-robbed (A/B) signaling or single frequency (SF) signaling.
7	To listen on the channel, use the sixth soft key to select monitor (MON in In-Line or DCS modes) or idle (IDLE in Terminal mode).
8	To control, talk, and dial on the channel, use the sixth soft key to select drop-and-insert (D&I) in any mode. When D&I is selected, the selected channel is taken out of service, and it is then possible to talk on the channel.
9	*For DCS mode*, proceed to Step 14. *For In-Line and Terminal modes*, press the MEAS key in the DISPLAY section of the keyboard. Refer to Figure 4-10 for bit-robbed signaling and Figure 4-11 for SF signaling.
10	The first soft key is used with the keypad to select the channel number from 01 to 30.
11	The second key is used to select the drop-and-insert direction, which can be east (e), west (w), or if in the In-Line conference mode, both directions simultaneously. Select the appropriate direction.
	Note: You cannot dial in conference, only talk and listen once the connection is made. Lowercase letters indicate monitor or idle; uppercase letters indicate drop-and-insert is active.

STEP	PERFORMING PCM DIAL/TALK (continued)
12	The third and fourth keys are used with the keypad to enter the signaling bits transmitted during drop-and-insert (D&I) in the east and west directions respectively. Set the A an B bits for superframe, and the ABCD bits for ESF in the unused direction to the state desired (idle or busy), so that when D&I is activated, the channel signaling is properly conditioned. The third and fourth soft keys can also used to set the state of SF signaling in the unused direction during drop-and-insert. SF indicates tone on or idle, and sf indicates no tone or busy is transmitted when D&I is activated.
13	The next two areas of the display show the status of the receive PCM in each direction, or the receive signaling state of the signaling bits or the SF detector. If there is a loss of signal (NOPCM), or remote frame alignment alarm (RFALM), they are displayed; otherwise, the signaling state appears. The fifth and seventh soft keys allow the selection of the receive or "from" direction. Uppercase letters indicate the selected "from" direction. *Note: Selection of a "to" direction automatically selects the same "from" direction.*
14	For DCS Mode, press the MEAS key in the DISPLAY section of the keyboard. Refer to Figure 4-12 for robbed-bit signaling and Figure 4-13 for SF signaling.
15	The first soft key is used with the keypad to select the test port number from 01 to 12.
16	The second key is used to select the drop-and-insert direction, which can be odd (0), even (E), or conference (CONF) which is both directions simultaneously. *Note: You cannot dial in conference, only talk and listen once the connection is made. Lowercase letters indicate monitor or idle; uppercase letters indicate drop-and-insert is active.*
17	The third and fourth keys are used to enter the signaling bits transmitted during drop-and-insert (D&I) in the odd and even directions respectively. Set the A and B bits for superframe and ABCD bits for ESF in the unused direction to the state desired (idle or busy), so. that when D&I is activated, the channel signaling is properly conditioned. The third and fourth soft keys can also used to set the state of SF signaling in the unused direction during drop-and-insert. When D&I is activated, SF indicates that tone on or idle is transmitted, while sf indicates that no tone or busy is transmitted.

STEP	PERFORMING PCM DIAL/TALK (continued)
18	The next two areas of the display show the status of the receive PCM in each direction, or the receive signaling state of the signaling bits or the SF detector. If there is a loss of signal (NOPCM), remote frame alignment alarm (RFALM), or AIS (all 1s), they are displayed; otherwise, the signaling state appears. The fifth and seventh soft keys allow selection of the receive or "from" direction. Uppercase letters indicate the selected "from" direction. *Note: Selection of a "to" direction automatically selects the same "from" direction.*
19	The CTS is now ready to seize the channel. This is accomplished by pressing the SET UP key, which returns you to the Setup display, and pressing the sixth soft key to enter drop-and-insert (D&I). Press the MEAS key.
20	Press the "+" key on the keypad and listen for a dial tone on the MONITOR speaker. You are now off-hook in the selected "TO" direction. If wink detect was selected (WNKD), the detection report appears on the left half of the display. The results can be: WINK, OFF HOOK (glare), or NO DETECTION (on-hook). If OFF HOOK or NO DETECTION is determined, the CTS returns to the ON HOOK state.
21	Now dial using the ENTER keypad and, if necessary, the auxiliary characters for DTMF and MF by pressing the SET UP key. Note that automatic dial may be used in PCM just as in VF (refer to Paragraph 4.5.4).
22	Once the connection is made, the TO/FROM/TALK switch is depressed to talk and released to listen. The MONITOR control can be set to a comfortable listening level. To talk, speak into the MONITOR speaker.
23	If it is necessary to redial, press the "-" key on the ENTER keypad to drop the connection, then press the "+" key and listen for dial tone or watch for a wink detection before dialing.
24	If an external handset is used, connect the handset to the DIAL/TALK bantam jack on the front panel.
25	Use the switch hook control on the handset to go offhook.
26	Once dial tone is received or wink detection is complete, use the handset to enter the number to be dialed.

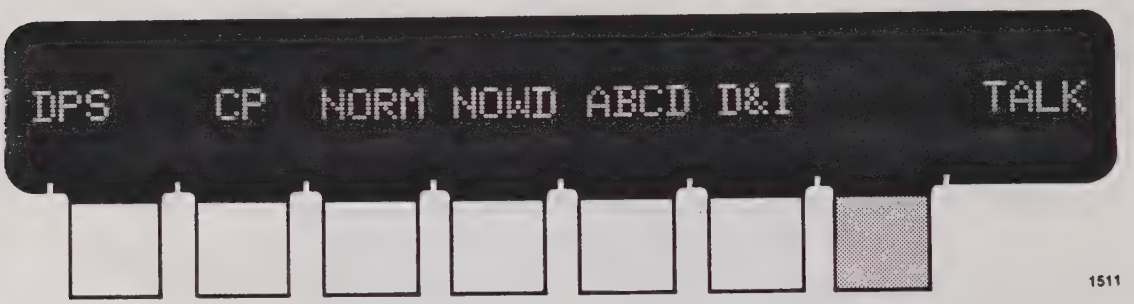


Figure 4-10. PCM Dial/Talk Setup Display (With Option .35A or .35C)

Figure 4-11. PCM In-Line and Terminal Dial/Talk ABCD Bit Measurement Display

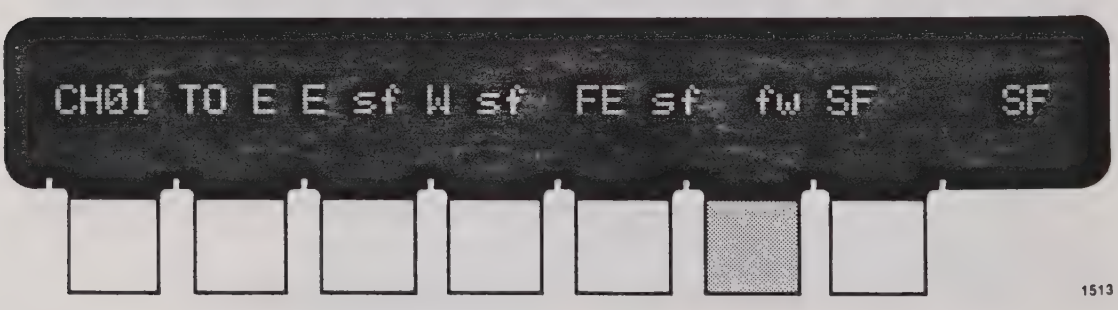


Figure 4-12. PCM In-Line and Terminal Dial/Talk SF Measurement Display

Figure 4-13. PCM DCS Dial/Talk Robbed-Bit Measurement Display

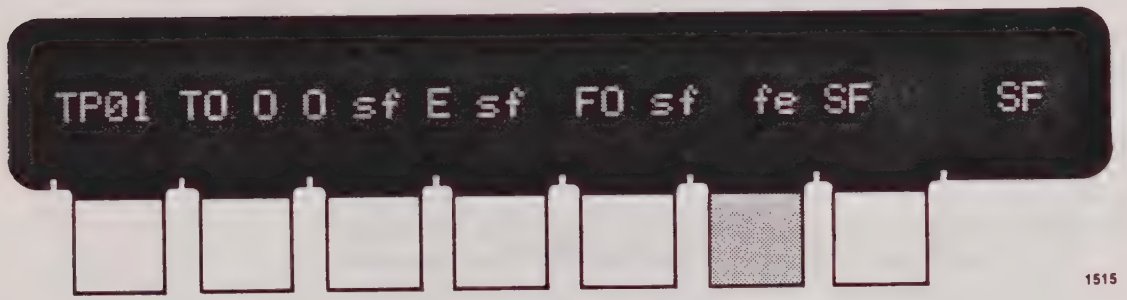
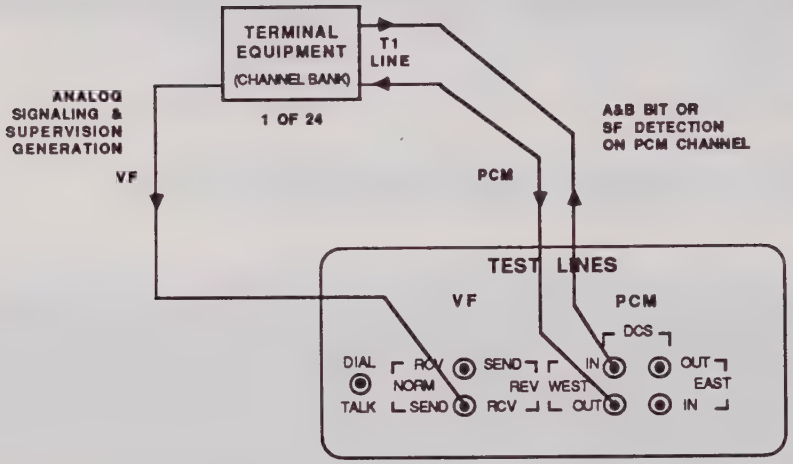


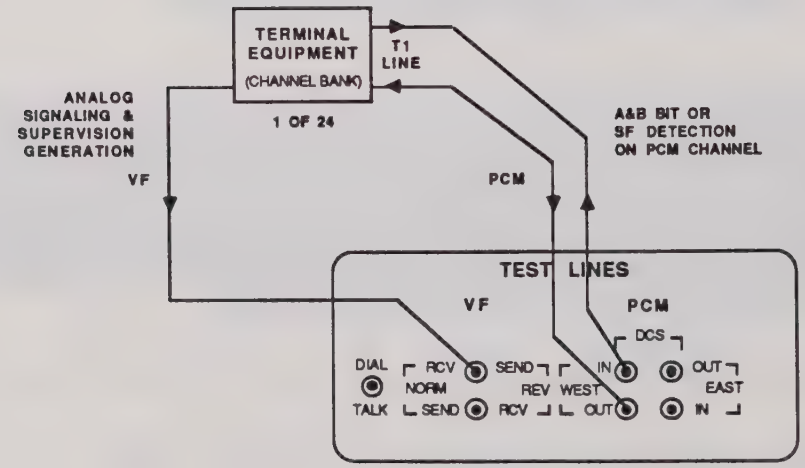
Figure 4-14. PCM DCS Dial/Talk SF Measurement Display

4.5.3.2 Terminal Mode Analog Operation

When the Terminal mode is selected in PCM, and the PCM to PCM configuration is active, dial/talk is performed according to the procedure in Paragraph 4.5.3.. However, if VF to PCM or PCM to VF are selected, analog dial/talk functions are involved as well as PCM. The typical application for this mode is testing a channel card in a channel bank. (Refer to Figure 4-15). In this mode, both the VF dial/talk setup and measurement displays are available using the SET UP and MEAS keys.



VF TO PCM



PCM TO VF

333A

Figure 4-15. Terminal Mode Dial/Talk Typical Configurations

4.5.3.3 FXS and FXO Foreign Exchange Signaling Sequences

The CTS has special features for testing both the station and office ends of a foreign exchange circuit on a PCM channel. These sequences exercise the functions of the circuits whether robbed-bit or SF signaling is used, and whether the circuit is ground-start or loop-start.

When testing toward the office, the CTS simulates a station, idling the circuit toward the actual station so that it receives no extraneous ringing. When testing toward the station, the CTS simulates an office, idling the circuit toward the actual office so that no office equipment is tied up by the testing.

To perform an FX circuit test with PCM active, press the DIAL/TALK key in the TEST LINES section of the front panel and perform the following procedure:

STEP	FX CIRCUIT TEST WITH PCM ACTIVE
1	Press the third soft key to select the type of FX sequence desired; office loop-start (FXOLS) or groundstart (FXOGS), or station loop-start (FXSLS) or groundstart (FXSGS). See Figure 4-16 Typical PCM Foreign Exchange testing for reference.
2	Use the fifth soft key to select the signaling type, either A and B bit (A/B) or SF. When ready, select drop-and-insert (D&I) using the sixth soft key.
3	Press the MEAS key to show the appropriate PCM dial/talk measurement display.
4	To initiate an FX sequence, press the "+" key in the keypad. This corresponds to initiating a call in the station simulation mode, and ringing a station in the office simulation mode.
5	Correct execution of the FX sequence results in the message SEQUENCE COMPLETE appearing in the left half of the measurement display. In the station simulation mode, dialing is enabled. If automatic dial is active, the dial sequence begins. The result should be a connection. In the office simulation mode, if the station answers the incoming call, you may then talk and listen using the station.
6	Incorrect execution of the FX sequence terminates the sequence and displays an appropriate message in the measurement display. In the station simulation mode, dialing is inhibited; if automatic dial is active, the dialing sequence is omitted.
7	The sequence may be aborted at any time by pressing the "-" key on the keyboard. This restores the signaling to the initial state for that selected sequence.

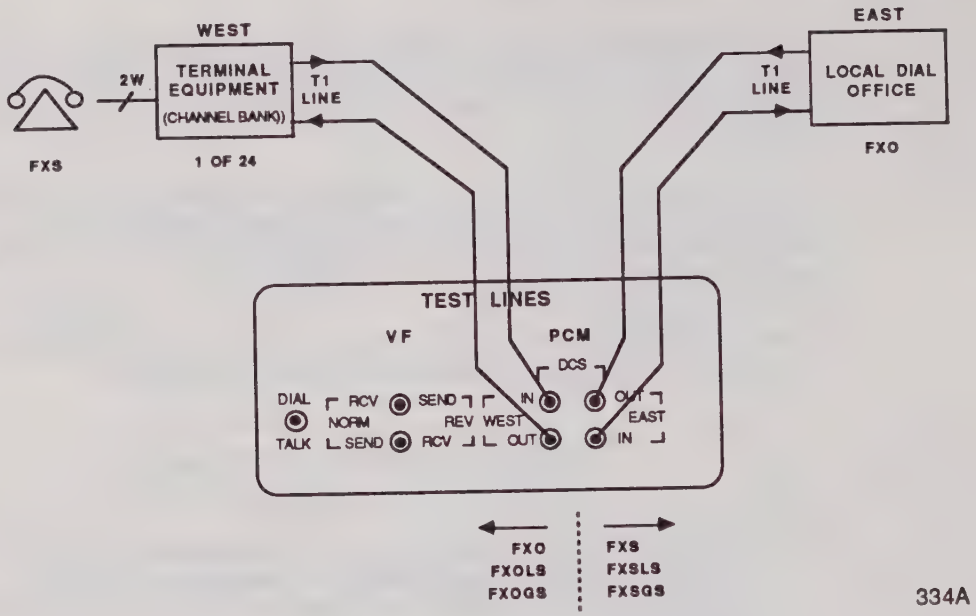


Figure 4-16. Typical PCM Foreign Exchange Testing

FX Office Loop-Start (FXOLS)

Initial state when FXOLS is selected:

TO	A,B	SF	STATE
OFFICE	0,1	ON	idle
STATION	0,1	OFF	idle

When the sequence is initiated by pressing the "+" key on the keypad, the following steps occur:

1) Line busy (A = 1, SF off) from the station is tested. If true, the message LINE BUSY is displayed, and the sequence terminated from the station.

2) If line busy is false, a 3-ring sequence is initiated by setting the B bit to 0 or SF on for 2 seconds, and then 1 or SF off for 4 seconds, repeated 3 times.

3) If at anytime line busy from the station becomes true (A = 1 or SF off), ringing is stopped and off-hook (B = 1) is sent to the station. The message SEQUENCE COMPLETE appears, and you may talk/listen to the station.

4) If the station remains idle (A=O, SF on) during the three ring cycles, the message NO ANSWER will appear, and the sequence is terminated.

FX Office Ground-Start (FXOGS)

Initial state when FXOGS is selected:

TO	A,B	SF	STATE
OFFICE	0,1	ON	idle
STATION	0,1	ON	idle

When the sequence is initiated by pressing the "+" key on the keypad, the following steps occur:

1) Ring ground (B = O, SF off) from the station is tested. If true, the message RING GROUND is displayed, and the sequence is terminated.

2) If ring ground from the station is false, then line busy (A = 1, B = 1, SF off) is tested. If true, the message LINE BUSY is displayed, and the sequence is terminated.

3) If line busy from the station is false, a three-ring sequence is initiated by setting the B bit to 0 or 20 Hz pulsing SF for 2 seconds, and then 1 or SF off for 4 seconds, repeated 3 times.

4) If at anytime line busy from the station becomes true (A = 1 or SF off), then ringing is stopped, and off-hook (B = 1, SF off) is sent to the station. The message SEQUENCE COMPLETE appears, and you may talk/listen to the station.

5) If the station remains idle (A=O, B=1, SF on) during the three ring cycles, the message NO ANSWER appears, and the sequence is terminated.

FX Station Loop-Start (FXSLS)

Initial state when FXOLS is selected:

TO	A,B	SF	STATE
STATION	0,1	OFF	idle
OFFICE	0,1	ON	idle

When the sequence is initiated by pressing the "+" key on the keypad, the following steps occur:

1) 5 seconds is spent looking for incoming ring (B=O, SF on from the office. If true, the message INCOMING RING is displayed, dialing is inhibited, and the sequence is terminated.

2) If there is no incoming ring detected for 5 seconds, then off-hook (A=1, B=1, SF off) is sent to the office, and the message SEQUENCE COMPLETE is displayed. Dialing is permitted, and if automatic dial is active, the dial sequence is initiated.

FX Station Ground-Start (FXSGS)

Initial state when FXOLS is selected:

TO	A,B	SF	STATE
STATION	1,1	ON	idle
OFFICE	0,1	ON	idle

When the sequence is initiated by pressing the "+" key on the keypad, the following steps occur:

1) Incoming ring is tested from the office. For SF this is up to a 5-second sequence of looking for SF pulsed at a 20 Hz rate, with 2 seconds pulsed on and 4 seconds off. For A and B bit signaling, this involves checking for B = O from the office. If true, then the message INCOMING RING is displayed, dialing is inhibited, and the sequence is terminated.

2) If incoming ring is false, then busy at the office is tested (A = O, SF off). If true, the message LINE BUSY is displayed, dialing is inhibited, and the sequence is terminated.

3) Now that the office has been tested and found to be in the idle state (A, B = 1, 1; SF on), ring-ground at the station is simulated by setting A, B = O, O or SF off to the office. If the office responds with busy (A, B = O, I; SF off), then the message SEQUENCE COMPLETE is displayed, dialing is permitted, and if automatic dial is active, the dial sequence is initiated.

4) If the office remains idle (A, B = 1, 1; SF on), then the message NO TIP GROUND is displayed, dialing is inhibited, and the sequence is terminated.

4.5.4 VF Automatic Dial

The CTS has the capability to store up to 99 dial numbers, each with up to 40 characters. This feature permits redial of an entered number with a single key press. The auto dial feature is controlled in the Automatic Dial Setup Display. This display is entered by pressing the SET UP key after pressing the DIAL/TALK key, and appears as in Figure 4-17.

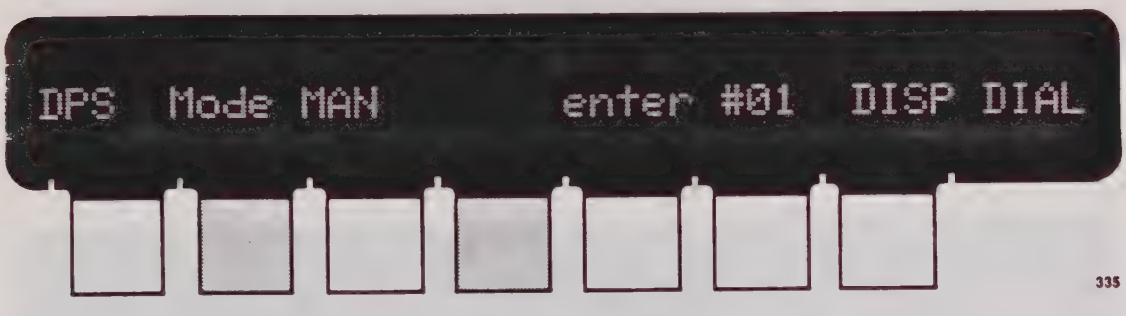


Figure 4-17. VF Automatic Dial Setup Display

Addressing Type Selection: The first soft key is used to select dial pulse (DPS), DTMF tone, or MF tone dialing. This selection is tagged to the auto dial number when it is entered.

Mode Selection: The third soft key is used to select either the manual dialing mode (MAN), in which the keypad is used to send out digits as the keys are pressed; or the automatic dialing mode (AUTO), in which the specified number is dialed with a single press of the "+" key.

Automatic Dialing Entry: The fifth soft key toggles ENTER on (all caps) and off (all lowercase). When ENTER is on, the digits entered from the keypad, and the special digits for DTMF and MF which are entered using the soft keys, are stored in a register of up to 40 digits: these digits are not dialed. ENTER must be off, and the Automatic mode selected to automatic dial. While ENTER is on, the dial display with the extra DTMF and MF digits may be accessed by pressing the SET UP key. If these digits are pressed, they will be stored. While ENTER is on, the "-" key is entered and causes a one-second delay in the auto dialing sequence. The "+" key is entered and initiates a wink detection at that point in the sequence if the unit is properly equipped. When ENTER is off, the "+" key initiates an auto dial sequence, and the "-" key scrubs it.

Register Number: The selected automatic dial register number is entered by pressing the sixth soft key, and using the keypad to enter the two-digit number between 01 and 99 with ENTER off.

Display Feature: The digits entered in the register selected are displayed by pressing the seventh soft key under DISP. The first 30 digits appear; to view the last 10 digits, press the seventh soft key again. To cancel the display, press the SET UP key.

Sample sequence for entering an Automatic Dial Number:

STEP	ENTERING AUTOMATIC DIAL NUMBER
1	Ensure that ENTER is off (lowercase letters). If necessary, press the fifth soft key.
2	Press the sixth soft key. Using the keypad, enter the two-digit register number 01.
3	Press the seventh soft key under DISP. Check that the register is empty or contains a number to be erased.
4	Press the SET UP key to restore the setup display.
5	Choose the type of dialing (dial pulse (DPS), DTMF tone, or MF tone) with the first soft key.
6	Now press the soft key under ENTER so that it changes to all uppercase. Press the soft key under DISP and use the keypad to enter the number to be automatically dialed.
7	Press the SET UP key to restore the setup display.
8	Press the sixth soft key under ENTER to turn it off.
9	Now select the display from which you wish to dial, and press the "+" key on the keypad.

4.5.5 DTMF/MF Signaling

DTMF/MF Signaling is standard on all test systems with Firmware Revision 12 or later. It is possible to generate DTMF (dual tone multifrequency) and MF (multifrequency) signaling from the dial/talk display. To select DTMF or MF, press the soft key under DPS (dial pulse signaling) and DTMF appears; pressing the soft key again causes MF to appear. The additional digits of DTMF and MF signaling are available by pressing the SET UP key; the DIAL display appears and the soft keys are appropriately labeled. To return to the TALK display, press the SET UP key. Refer to Figure 4-18 for the DTMF control digit display and Figure 4-18 for the MF control digit display.

The dialing operation of the CTS with DTMF or MF selected is the same as for dial pulsing. The "+" key is used for off-hook, and the "-" key is used for on-hook. The tone duration of the DTMF digits is 80 milliseconds, and the interdigit interval is 80 milliseconds. The tone duration of MF digits is 75 milliseconds, except for KP1 and KP2 which are 120 milliseconds, and the interdigit interval which is 75 milliseconds. The frequency accuracy of the tones is ±0.7%.

The amplitude of the tones is controlled by the send level of the CTS, except in remote-control operation; QUIET TERM may be set before dialing, and the previously set send level is used. During remote-control operation, the DTMF and MF tone level is controlled by the send level command until an SMFL command has been issued. The output amplitude of each of the tones is equal and 3 dB below the send level value. The output level accuracy is ±0.5 dB. The DTMF and MF digits and their tone frequencies are described in Addendum A.

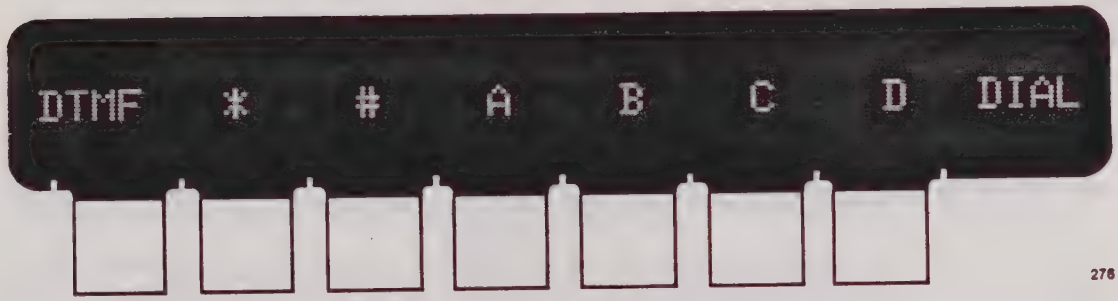


Figure 4-18. DTMF Signaling Dial Display

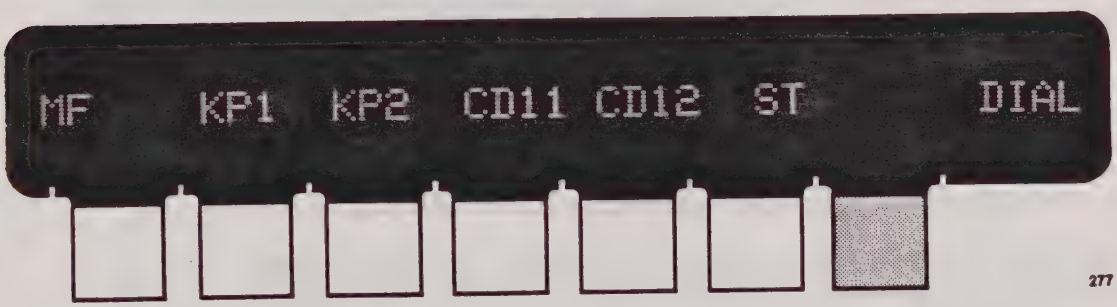


Figure 4-19. MF Signaling Dial Display

4.5.6 Call Progress and Signaling (Option .35A or .35C)

Call Progress and Signaling (Option .35A or .35C) is a sophisticated signaling interface that permits the CTS to direct dial test connections under front-panel control or under full remote control. Call progress and wink detection permit automated systems to determine if a call has been routed properly, and to act accordingly. Options .35A and .35C handle signaling for loop-start and ground-start 2-wire systems, and include reverse battery detection and reverse battery wink detection for loop-start systems so equipped.

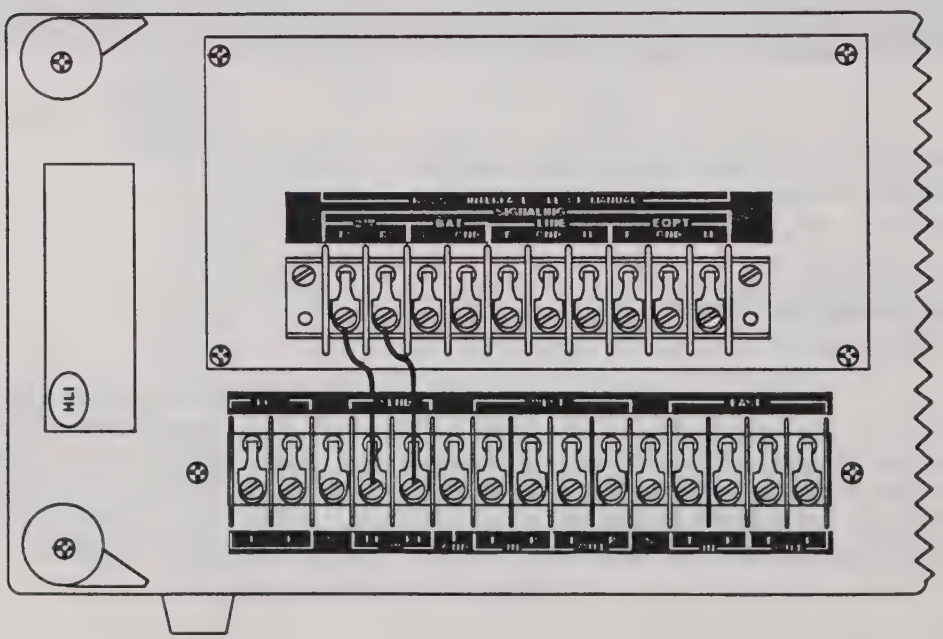
Call progress detection is particularly useful in REACT System applications where an operator is not present at the CTS to determine if dial tone is present, or if the dialed call encounters a line busy or trunk busy signal. Option .35A also performs line status, seizure, wink detection, dial pulsing on E and M signaling systems, and DTMF digit detection. Option .35C performs all these Option .35A functions, and also performs Single-Frequency (SF) signaling, and MF and dial pulse digit detection.

4.5.6.1 Connections to Option .35A or .35C

The CTS has an additional rear panel barrier strip labeled SIGNALING when Option .35A or .35C is installed (see Figure 4-20). Status for loop-start and ground-start signaling is measured at the 2W T_1(tip) and R_1 (ring) terminals on this barrier strip. Also, E, M, and GND leads must be connected at this barrier strip, plus station battery and ground. The Option .35A or .35C ground connection is isolated from the CTS chassis, and must be connected to station ground or chassis ground for proper operation.

For 2-wire status and dialing, the 2W T_1 and R_1 terminals on the SIGNALING barrier strip should be paralleled with the SEND 2W T_1 (tip) and R_1 (ring) terminals on the Test Line Connections barrier strip.

WARNING: Application of incoming ring voltage to the CTS TEST LINES connectors may cause permanent damage to the test set. Do not allow incoming ring to be applied to the RCV or DIAL/TALK jacks. Do not allow incoming ring to be applied to the SEND jack unless dial/talk is active and onhook has been selected. Carefully observe the following instructions to avoid damage.



561A

Figure 4-20. Option .35A or .35C Barrier Strip Connections

4.5.6.2 Setup Procedures

All operating modes are accessed by pressing the DIAL/TALK key on the front panel. Status displays are, in general, available by pressing the MEAS key, and pressing the SET UP key returns the user to the Setup display.

See Figure 4-21 for a view of the VF dial/talk setup display with Option .35A or .35C installed. The various options are discussed, working from left to right.

Figure 4-21. VF Dial/Talk Setup Display (With Option .35A or .35C)

Dialing Options: The first soft key steps through choices of DPS, DTMF, and MF dialing. DPS must be selected to outpulse on E and M signaling systems.

Call Progress: CP is continuously displayed over the second soft key. The second soft key, when pressed, changes the display immediately to indicate the presence of call progress tones at the TEST LINES VF NORM-RCV jack. This is a momentary feature, and the displayed messages are: DIAL TONE, LINE BUSY, TRUNK BUSY, or NO TONE. After a five-second time-out period, the display returns to the Setup display.

2-wire/4-wire Selection: The third soft key, when pressed, toggles between 2W and 4W. The setting should be 2W for loop-start and ground-start signaling, and 4W for E&M and SF signaling. The selection controls the source of the monitor receive signal. This control selects the port which is monitored for the receive signal. In 4W, the receive jack is selected. In 2W, the receive port of the internal hybrid circuit, which is connected to the send jack, is selected.

Signaling Method Selection: The fifth soft key, when pressed, steps through choices of LPST (loop-start), GRST (ground-start), E&M1 (E&M type 1). E&M2 (E&M type 2), E&M3 (E&M type 3), E&M4 (E&M type 4), E&M5 (E&M type 5), CCITT R1 SF (for Option .35C), and NONE (for 4W dry circuits with no supervision, such as private line data). Select the desired signaling method and proceed to the applicable explanation in Paragraph 4.5.6.

Normal/Reverse Selection: The sixth soft key is used to select NORM or REV. This exchanges the roles of the send and receive jacks on the front and rear panels.

Hold Circuit On/Off: The seventh soft key enables the hold circuits on the send and receive lines. The appearance of all capital letters indicates that the function is enabled. If E and M signaling or NONE is selected, this position is blank.

4.5.6.5 Measurement Displays

Measurement displays for Options .35A and .35C are defined in the following paragraphs. The measurement display for loopstart signaling is shown in Figure 4-22.

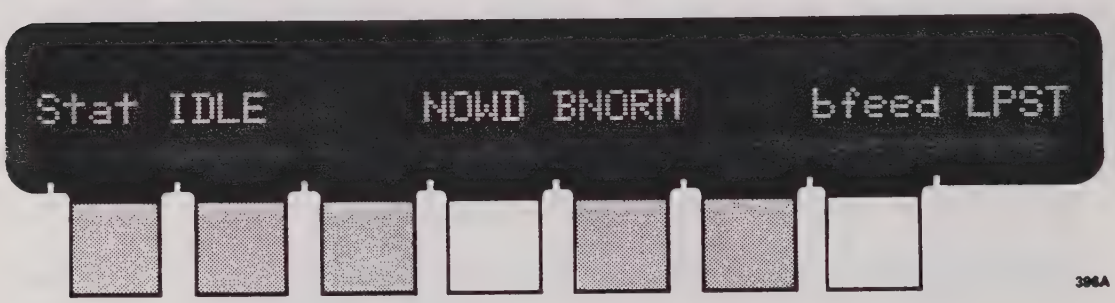


Figure 4-22. Loop-Start Measurement Display

4.5.6.4 Loop-Start Signaling

Supervision Status Display: The status indication indicates BUSY or IDLE, depending on the status of the line connected to the 2W T_1 and R_1 terminals of the SIGNALING rear panel barrier strip.

Wink Detection Enable: Wink detection is enabled by pressing the fourth soft key under NOWD (no wink detection), causing WNKD (wink detection) to appear. When the CTS executes a line seizure (press the "+" key), the reverse battery wink detector automatically activates and displays the appropriate message for a five-second period after the line is seized. The messages are SHORT WINK, WINK, OFF-HOOK, or NO DETECTION. If SHORT WINK, OFF HOOK, or NO DETECTION occurs, the CTS returns to the on-hook state.

Battery Polarity Display: Above the fifth soft key position is a status display for the polarity of the circuit applied to the tip and Ring inputs. Normally this indicates BNORM, meaning the station battery polarity is normal. Some signaling systems, however, use a battery reversal to signal an off-hook condition at the distant end. If the battery should be reversed, the status display indicates BREV.

Battery Feed Enable: The seventh soft key enables the battery feed circuit to supply talk battery on a local loop. When the BFEED label is indicated in uppercase letters, the function is enabled.

Manual dialing may be initiated from this display by connecting the 2-wire line to the TEST LINES VF NORM-SEND jack in parallel with the 2W T and R terminals on the SIGNALING rear panel barrier strip. Then press the "+" button on the keypad to seize the line, and listen for dial tone with the MONITOR switch in the SEND position. Also note that the Status display changes from IDLE to BUSY. The desired phone number may be dialed on the keypad, and the dialing method is as previously selected in the Setup display. Automatic dial may also be used to perform this function. When the call is completed, pressing the "-" key on the keypad terminates the call.

4.5.6.5 Ground-Start Signaling

The Measurement display for ground-start signaling is shown in Figure 4-23.

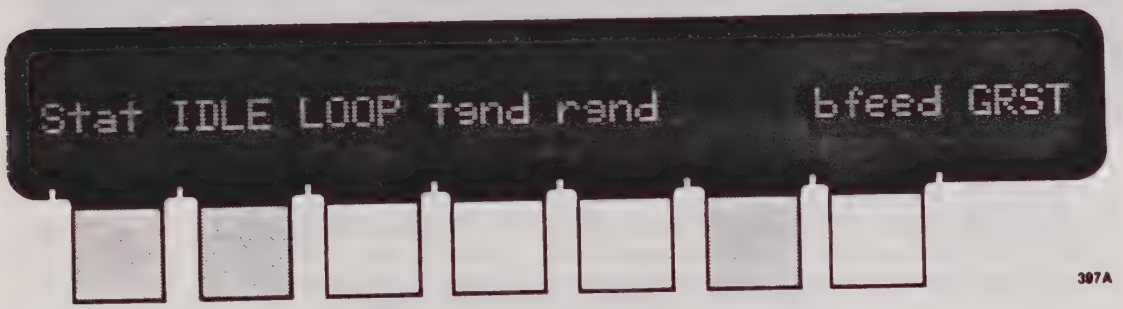


Figure 4-23. Ground-Start Measurement Display

Supervision Status Display: The status indication if LOOP detection is selected is BUSY or IDLE, or if TGND (tip ground) detection is selected it indicates GND or OPEN.

Detection Selection: To select LOOP status detection, press the third soft key under loop, and it changes to all uppercase characters. To select TGND (tip ground) detection, press the fourth soft key under TGND.

Ring-Ground Control: To apply a ring ground to the ground-start circuit, press the fifth soft key under rgnd, and it changes to uppercase characters. To release the ring ground, press the soft key again.

A ground-start circuit can be seized by first examining the BUSY/IDLE indicator to determine if the line is active, then activating the TGND detector and turning on RGND. The status indicator should change from OPEN to GND to indicate a response from the central office. The 2-wire hold circuit should now be enabled. Disable RGND by pressing it once more.

Battery Feed Enable: The seventh soft key enables the battery feed circuit to supply talk battery on a local loop. When the BFEED label is indicated in uppercase characters, the function is enabled.

4.5.6.6 E and M Signaling

The Measurement displays for all types of E and M signaling are identical, so this section applies to E and M signaling types 1 through 5, inclusive.

Connections: E and M signaling leads are connected to the SIGNALING rear panel barrier strip, observing the line (facility) and equipment (drop) directions. The E and M leads are normally through-connected, and THRU is displayed until a SPLIT command is selected from the front panel. To properly seize an E and M circuit requires station battery and ground connections at the SIGNALING rear panel barrier strip. The Measurement display for E and M signaling is shown in Figure 4-24.

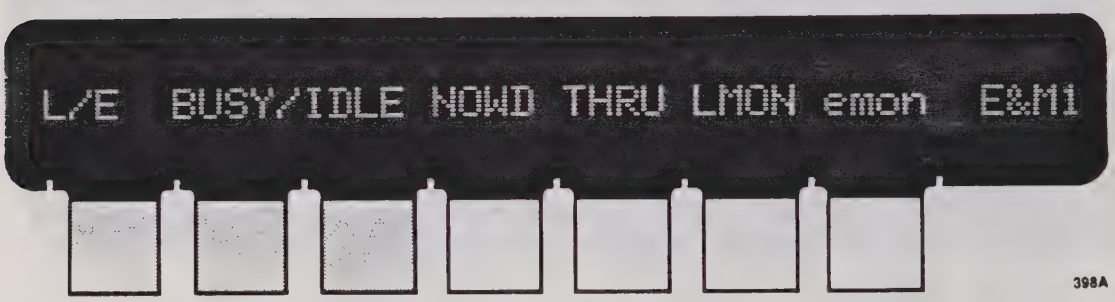


Figure 4-24. E and M Measurement Display

Supervision Status Display: The indication (BUSY or IDLE) to the left of the slash mark shows the received status of the E lead from the line direction. The indication to the right of the slash mark shows the received status of the M lead from the equipment direction.

Wink Detection Enable: Wink detection is enabled by pressing the fourth soft key under NOWD (no wink detection). WNKD (wink detection) then appears.

Monitor/Control Selection: The fifth soft key, when pressed, toggles between THRU and SPLT (split). When THRU is indicated, the displays above soft keys six and seven indicate the direction, equipment or line, which is monitored for dial pulses (see Section 4.5.6). The display in capital letters, LMON in Figure 4-22, indicates the selected direction. A direction is chosen by pressing the associated soft key. When SPLT (split) is indicated, displays above soft keys six and seven change, showing choices LREL (line side released) and EREL (equipment side released), respectively.

When the soft keys below LREL and EREL are pressed and wink detection is enabled, the BUSY/IDLE status display blanks momentarily and then returns with the wink message. The wink message will be SHORT WINK, WINK, OFF HOOK, or NO DETECTION. After a five-second timeout, the BUSY/IDLE status display returns. The display indicates LSEZ (line side seized) or ESEZ (equipment side seized), respectively, showing the circuit has been seized in that direction. For dial pulse decoding purposes, the last direction which is seized is monitored for dial pulses.

4.5.6.7 SF Signaling

The measurement display for SF signaling is shown in Figure 4-25.

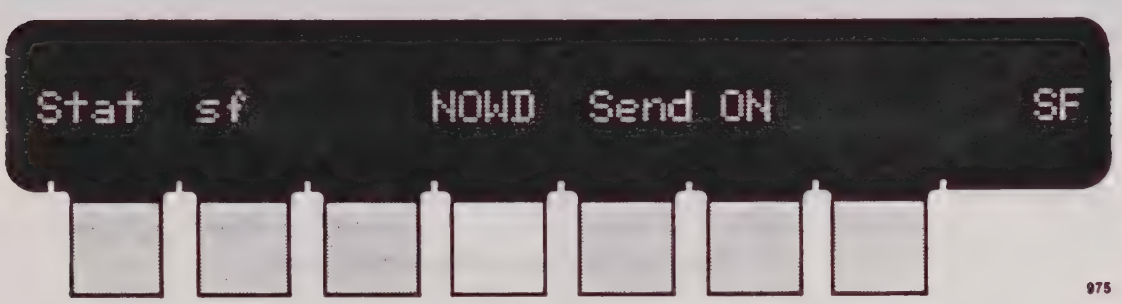


Figure 4-25. SF Measurement Display

Supervision Status Display: The status indication is sf for the absence of the tone or busy, and SF for the presence of tone or idle.

Wink Detection Enable: Wink detection is enabled by pressing the fourth soft key under NOWD (no wink detection). WNKD (wink detection) then appears above the soft key. Wink detection is keyed to the transition of the supervision control from idle to busy.

Send Side Condition Display: Following the label send is the status of the SF supervision on the Send side. Idle condition is indicated with ON, and 2600 Hz tone appears on the send side. Busy is indicated with OFF, and no tone appears on the send side. Control of the supervision is performed with the keypad "+" and "-" keys. The "-" key results in an immediate idle condition; the "+" key causes off-hook, and initiates dialing if automatic dial is set. Refer to Section 4.5.4, VF Automatic Dial. The transmit level of the SF tone is initially 8 dB below the send level set in the Send SETUP Display, and then remains at 20 dB below the send level. The higher level is also used during pulsed SF dialing.

4.5.6.8 Address Signaling Detection

The Option .35C provides central office quality detection of DTMF and MF tones, and dial pulses. The Option .35A provides only DTMF tone detection. Address Signaling tones and pulsing are detected in dial/talk mode only. To receive digits, press the DIAL/TALK key and then the SETUP key three times to show the Address Digit Receive Display shown in Figure 4-26. The source of the dial pulse decoding is selected by the signaling method selection in Section 4.5.6.

Tone and Pulse Selection: For Option .35C, the first soft key selects the type of digits to be detected; dial pulse, or DTMF or MF tones. This selection follows the send dialing option if it is changed, but may be independently set in this display. For Option .35A, DTMF is always displayed, and the soft key does not function.

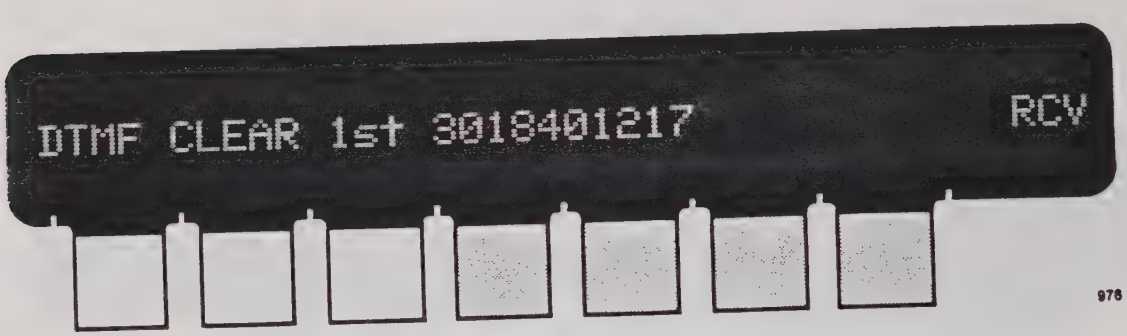


Figure 4-26. Address Digit Receive Display

Digit Buffer Clear: The second soft key is used to clear the 40-digit receive buffer.

Display Line Selection: The third soft key allows the display of digits up to the maximum capacity of 40 digits. There are 20 digits in each of the two display lines; the first line is always filled first. The twenty-first digit causes the display to advance to the second line. Clearing the buffer returns the display to the first line. Digits received beyond the 40-digit limit overwrite the fortieth digit.

4.6 Signal Generator Setup

This section describes the send level, send frequency and sweep setup procedures for the CTS. The front panel section labeled GENERATOR is used to control the level of all internally generated test signals, and the frequency of the sine-wave generator. A QUIET TERM key is provided to permit quieting of the send signal with a single key press. A fixed level/frequency key for 1004 Hz test tone at -16 dBm is provided to permit activation of standard test tone with a single key press.

4.6.1 Generator Setup

A flexible sweep capability facilitates attenuation distortion and delay distortion versus frequency measurements. If an option which generates its own send signal is installed, the measurement test signal is replaced by the test tone signal when the fixed level/frequency key is activated. The generator functions are active when the LEDs in their respective keys are lit. The programmable generator is activated by toggling off any of the other active generator function keys. The LED in the SEND key then lights.

By pressing the SEND key, the SEND display (Figure 4-27) appears and permits setting of the generator parameters using the soft keys and ENTER keypad. This can be done while another generator function is active, with the exception of setting frequency during a sweep. During a sweep, the SEND display shows the active sweeping send frequency. The FREQ↑ and FREQ↓ keys adjusts the programmable generator output up or down in 1, 10, 100 Hz, 1 kHz and, with Option .10, 10 kHz steps.

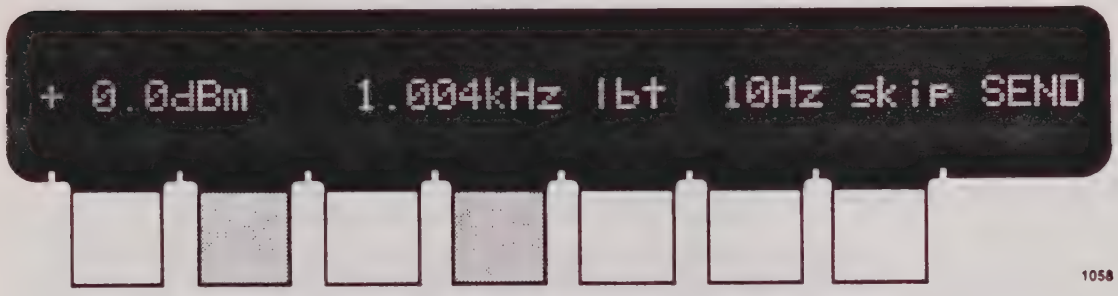


Figure 4-27. Send Setup Display

To generate a single step, press the desired key momentarily. To cause the frequency to change at a growing rate while in the CONT mode, press and hold the desired key until the desired rate of frequency change is obtained.

Send Level Set: To set the send level, press the first soft key under the level digits. All underlines appear. Enter the sign of the level to be entered and then most through least significant digits from the keypad. Levels of +10.0 to -70.0 dBm may be entered.

Send Frequency Set: To set the generator send frequency, press the third soft key under the frequency digits. All underlines appear. Enter the most through least significant digits from the keypad. Frequencies from 0.044 to 20.004 kHz (to 120.004 kHz with Option .10) may be entered.

Loop-back Tone Activate: To send the 829 loop-back tone of 2713 Hz, press the fifth soft key under lbt. The tone is transmitted at the set send level for two seconds or for as long as the key is depressed, whichever is longer. If QUIET TERM is set, it is released for the duration of the tone.

Send Frequency Step Size Selection: To select the send frequency step size, press the sixth soft key to advance. The available selections include 1 Hz, 10 Hz, 100 Hz, 1 kHz and, with Option .10, 10 kHz. All step sizes above 1 Hz include a 4 Hz offset.

SF Skip Selection: To activate generator SF skip from 2.454 to 2.754 kHz, press the seventh soft key under SKIP. The generator does not operate now between these frequencies. The SF skip is active when SKIP is all uppercase letters; press the soft key to toggle it off.

4.6.2 Sweep Setup

The sweep is initiated by pressing the SWEEP key in the GENERATOR section of the front panel when the SEND LED is lit. Pressing the SWEEP key while the QUIET TERM or 1004 Hz @ -16 dBm LED is lit causes the SWEEP display to appear but does not initiate a sweep. When the SWEEP LED is lit, pressing the SEND key displays the actual sweeping send frequency. To terminate a sweep, press the SWEEP key again, or press the QUIET TERM or 1004 Hz @ -16 dBm key.

The sweep function has set low and high limits, as well as three selectable sweep rates of 0.3, 1, and 3 steps per second. The sweep may be set to continuously sweep up and down, or to single sweep up, or to single sweep down. Depending upon the STEP option selected in the SEND display, the sweep changes in 1, 10, 100 Hz, 1 or 10 kHz increments. Refer to Figure 4-28 while performing the procedures in this section.

Set Sweep Limits: To set the sweep limits, press the soft key under the digits for Lo or Hi limit; all underlines replace the digits. Enter the most through least significant digits of the limit in kHz from the keypad. Limits from 0.04 to 20.00 kHz (to 120.00 kHz with Option .10) may be entered, and the low must always be less than the high.

Sweep Rate Selection: The fifth soft key, just to the left and below RATE, is used to select the sweep rate. Press the soft key to rotate through the selections: HI, MID, LO.

- HI for 3.0 steps per second
- MID for 1.0 steps per second
- LOW for 0.3 steps per second

Sweep Direction Selection: The far right soft key is used to select the sweep direction:

- AUTO for continuous up and down sweeps
- DOWN to sweep from Hi to Lo and stop
- UP to sweep from Lo to Hi and stop

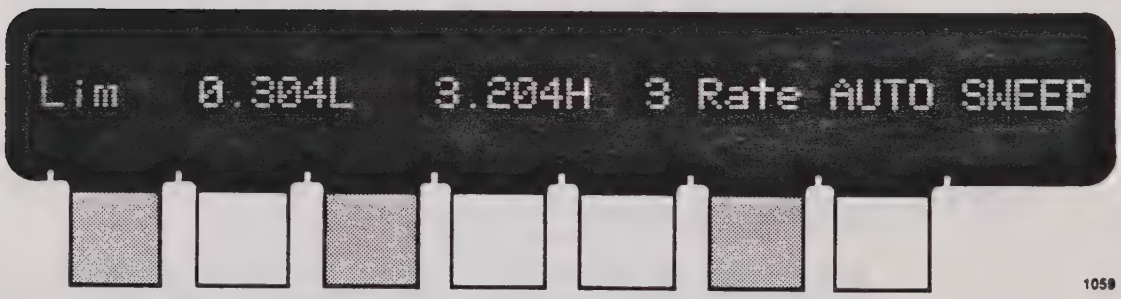


Figure 4-28. Sweep Setup Display

4.7 VF Testing

4.7.1 Level-Frequency-S/N Measurement

This section contains the procedures required for level, frequency and signal-to-noise measurements. The CTS can perform a variety of level measurements while simultaneously displaying a frequency and S/N (signal-to-noise) ratio measurement. All level measurements are made with an averaging detector calibrated to read the rms value for a sine wave. The level measurements are:

- Absolute level measurements in dBm
- Relative level measurement with respect to a TLP (transmission level point) dBm0 or an input level in dB.

Absolute level measurements are made whenever the TLP is set to 0 dBm, and the SET0 function is off. The MEAS display then displays level in dBm. Relative measurements with respect to a +10 to -40 dB TLP are made by entering the TLP in the SETUP display. This function provides up to 40 dB of gain or up to 10 dB of loss to the receive signal. Level measurements relative to an arbitrary receive level in the +10 to -40 dB range are initiated by activating SET0 in the SETUP display.

A switchable 60 Hz high pass filter is provided in the LEVEL MEAS display to determine the effects of 60 Hz components on the level reading. The switch is momentary to prevent erroneous measurements. The filter provides a minimum of 20 dB attenuation at 60 Hz. Provision is also made for extra damping of the receive level measurement, which may be activated in the LEVEL SETUP display. The additional damping may be used to improve the readability of a fluctuating receive level. When not needed, the DAMP control should be off to speed the measurement response time. Damping and S/N ratio measurements may not be simultaneously selected.

Signal-to-noise ratio measurements may be performed along with the level measurements. To perform a signal-to-noise ratio measurement, the distant end must be sending 1-kHz test tone. The CTS measures the receive level and the C-notch noise level, and calculates the ratio of these two signals in dB. The test tone must be in the +10 to -40 dBm level range, and the C-notch noise in the 10 to 100 dBrnC range. If either component of the measurement is out-of-range, the S/N ratio is displayed as **. For most accurate readings, set the TLP so that the relative receive level is approximately 0.0 dBm0.

During level measurements, the monitor signal is obtained directly from the receive signal. The monitor VOL control is used to adjust the listening level for various input levels.

4.7.1.1 Setup Procedure

To initiate a level measurement, press the LEVEL key in the front panel MEASUREMENT section and observe that its LED lights. Refer to Figures 4-29 and 4-31 while performing the procedures of this section.

Figure 4-29. Level Setup Display

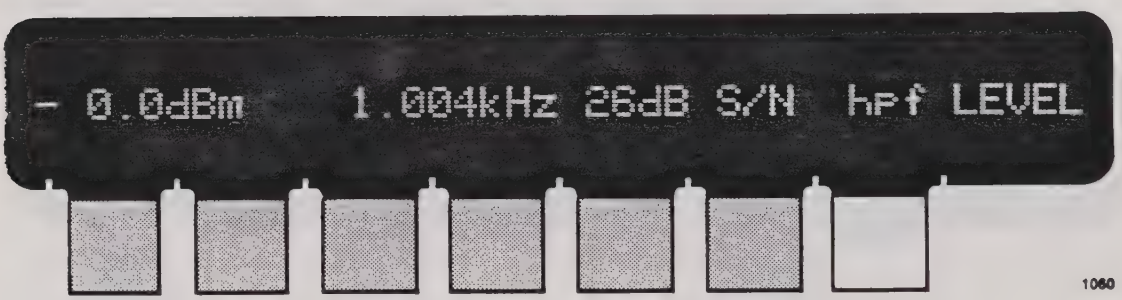


Figure 4-30. Level Measurement Display

S/N Ratio Measurement Selection: To make S/N ratio measurements along with the level and frequency measurements, press the third soft key under S/N. The S/N ratio measurement is active if S/N is all uppercase letters; to toggle it off, press the soft key again. It is not possible to have both S/N and DAMP selected simultaneously.

Relative Reference Set: To make level measurements relative to a reference point, press the fourth soft key under SET0 when the received level is at the reference point. The level measurements are then made with respect to this reference point. This function is active when SET0 is all uppercase letters; to toggle it off, press the soft key again.

TLP Entry: To enter a TLP for level measurements, press the fifth soft key under the TLP digits. The digits are all replaced by underlines. Using the keypad, enter a "+" or "-" sign, then the most through least significant digits. The TLP may be set between +10 and -40 dB. Enter 0 dB for absolute measurements. This function provides up to 40 dB of gain or up to 10 dB of loss to the receive signal.

Damping Selection: To reduce level reading fluctuations on a noisy receive signal, press the seventh soft key under DAMP. The high damping mode is selected when DAMP is all uppercase letters; to toggle it off, press the soft key again. It is not possible to select both DAMP and S/N simultaneously.

4.7.1.2 Measurement Display

Receive Level Measurement Display: The level measurement display is on the far left side of the display. The display range is +10.0 to -70.0 dBm (to -55 dBm with Option .10) for absolute level measurement. The units for the measurement are:

- dBm for absolute level measurements
- dBm0 for level measurements relative to a TLP
- dB for level measurements relative to a reference level

Receive Frequency Measurement Display: The frequency measurement display follows the level measurement display and is displayed in kHz with a resolution of 1 Hz from 0.040 to 20.100 kHz (10 Hz from 20.100 to 120.10 kHz with Option .10). If the receive level is below -51.9 dBm (or -41.9 dBm during an impulse noise or hits test), the digits of the frequency display are replaced by *.

S/N Ratio Measurement Display: The S/N ratio measurement display follows the frequency display. The S/N ratio is displayed in dB. The CTS must be receiving a 1-kHz test tone for this measurement.

High Pass Filter Selection: To insert the 60 Hz high pass filter, press the soft key under HPF. The switch is momentary and must be held until the reading stabilizes. The filter causes at least 20 dB attenuation at 60 Hz.

4.7.2 Noise Measurement

This section contains procedures for performing noise measurements. Refer to Figures 4-31 and 4-32 while performing these procedures.

The CTS uses an rms responding detector to perform noise measurements of the following types:

- Absolute noise measurements
- Noise measurements relative to a TLP (transmission level point)
- Absolute noise-to-ground measurements
- Noise-to-ground measurements relative to a TLP

The following filters are provided for weighting the receive signal:

- C-message filter
- 3-kHz flat filter
- 1010 Hz test tone notch filter
- Option .15 Noise Filters (if installed)
  -- 15 kHz Flat
  -- Program
- Option .15B Noise Filters (if installed)
  -- 15 kHz Flat
  -- 50 kilobit
- Option .15C Noise Filters (if installed with Option .10 only)
  -- 15 kHz Flat
  -- 50 kilobit
  -- 50 kHz Flat

The absolute noise measurements are made whenever the TLP is set to ± 0 dB. The MEAS display then displays noise in dBrn or dBrnC. The range of the absolute noise measurements is 10 to 100 dBrn, 20 to 100 dBrn for Option .10. Relative measurements with respect to a TLP are made by entering a TLP in the +10 to -40 dB range in the SETUP display. This function provides up to 40 dB of gain or up to 10 dB of loss to the receive signal.

Provision is made for extra damping of the receive noise measurement, which may be activated in the NOISE SETUP display. The additional damping may be used to improve the readability of a fluctuating noise measurement. When not needed, the DAMP control should be off to speed the measurement response time.

Noise-to-ground measurements are made by selecting NTG in the NOISE MEAS display. When NTG is active, the receive side is configured for noise-to-ground measurements with the appropriate noise weighting filters selected for the measurement. When making low level noise or noise-to-ground measurements, it is recommended that the generator be in quiet termination. This is accomplished by pressing the QUIET TERM key in the GENERATOR section of the front panel.

4.7.2.1 Setup Procedure

To initiate a noise measurement, press the NOISE key in the front panel MEASUREMENT section and observe that its LED is on. Refer to Figure 4-31.

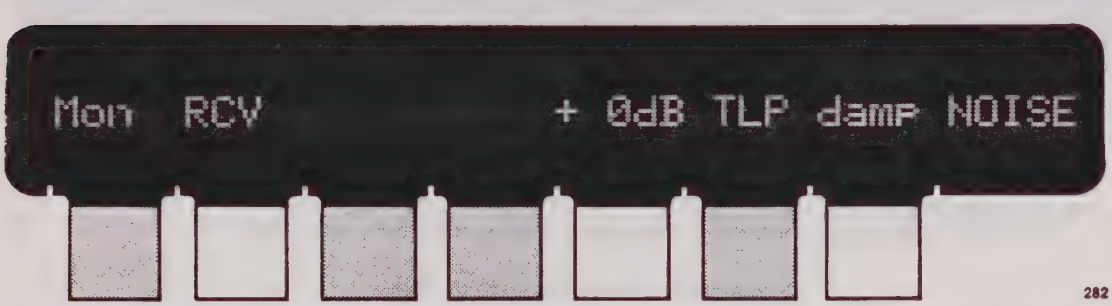


Figure 4-31. Noise Setup Display

Monitor Selection: During noise measurements, the monitor signal is obtained directly from the receive signal or from the leveled and weighted receive signal to aid in identifying the noise components. To select the leveled and weighted receive signal for the monitor, press the second soft key to the right of the label Mon and AGC appears. To return to monitoring the receive signal directly, toggle the soft key to RCV.

TLP Entry: To enter a TLP for noise measurements, press the fifth soft key under the TLP digits. The digits are all replaced by underlines. Enter a "+" or "-" sign, then the most through the least significant digits. The TLP may be set between +10 and -40 dB, with 0 dB entered for absolute noise measurements. This function provides up to 40 dB of gain or up to 10 dB of loss to the receive signal.

Damping Selection: To reduce noise-reading fluctuations, press the seventh soft key under DAMP. The high damping mode is selected when DAMP is all uppercase letters; to toggle it off, press the soft key again.

4.7.2.2 Measurement Display

The noise measurement display is shown in Figure 4-32.

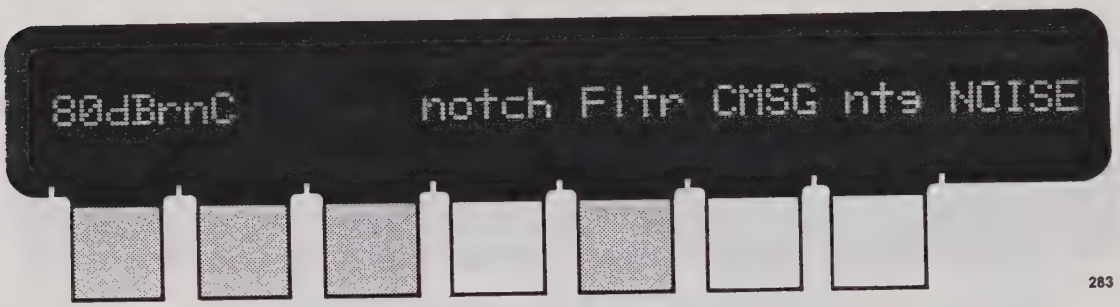


Figure 4-32. Noise Measurement Display

Receive Noise Measurement Display: The receive noise measurement display is on the far left side of the display. The display range is 10 to 100 dBrn (20 to 100 dBrn with Option .10) for absolute noise measurements. The units for the measurements are:

- dBrnC for C-Message weighted noise measurements
- dBrn for 3-kHz flat weighted noise measurements
- dBrnC0, dBrn0 for noise measurements relative to a TLP

1010 Hz Notch Filter Selection: To insert the 1010 Hz notch filter in the noise measurement path, press the fourth soft key under NOTCH. The notch filter is used with all noise-with-tone measurements. The notch filter is inserted when NOTCH is all uppercase letters; to toggle it off, press the soft key again.

Noise Weighting Filter Selection: To select a noise weighting filter, press the sixth soft key. The unit toggles through the available filters including the basic unit CMSG and 3-kHz Flat filters, the Option .15 Noise Filters (15 kHz Flat and Program), the Option .15B Noise Filters (15-kHz Flat and 50-kilobit filters), or the Option .15C Noise Filters (15 kHz Flat, 50 kilobit, and 50 kHz Flat) with Option .10.

Noise-To-Ground Measurement Selection: To select the noise-to-ground measurement configuration, press the seventh soft key under NTG. The display range is +40 to +130 dBrn (+50 to +130 dBrn with Option .10) for noise-to-ground measurements. This measurement is active when NTG is all uppercase letters; to toggle it off, press the soft key again.

4.7.3 Return Loss

This section describes procedures for return loss measurements, supported by Option .16. Option .16 (Return Loss) is standard in all Model 3705 CTSs with Revision 12 or greater firmware. This option is designed to perform three impedance 2W and four impedance 4W return loss measurements in accordance with IEEE Std 743/Bell PUB 41009. The option contains a generator which allows the measurement of echo return loss (ERL), low

frequency singing point return loss (SRLLO), and high frequency singing point return loss (SRLHI). Also provided is an echo suppressor disable tone, which is transmitted each time the option is activated and each time a front-panel soft key is pressed. The basic unit generator is used for sine wave return loss measurements.

Two damping conditions are provided; the Bell standard, as well as a faster response mode. Allow adequate settling time when using the standard damping. The MONITOR obtains its signal directly from the receive side when RLOSS is displayed.

4.7.3.1 Setup Procedures

To perform a return loss measurement, press the RTN LOSS key in the MEASUREMENT section of the front panel. For 2W measurement, the line under test must be connected to the NORM-SEND (2W) jack in the TEST LINES section of the front panel. Figures 4-33 and 4-34 show the return loss setup displays.

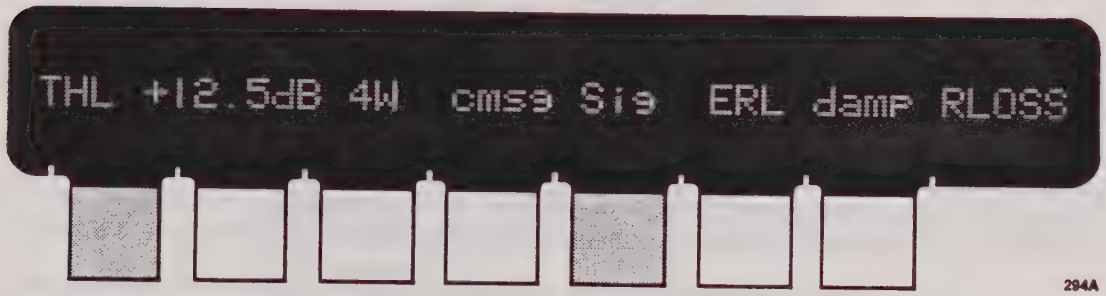


Figure 4-33. 4W Return Loss Setup Display

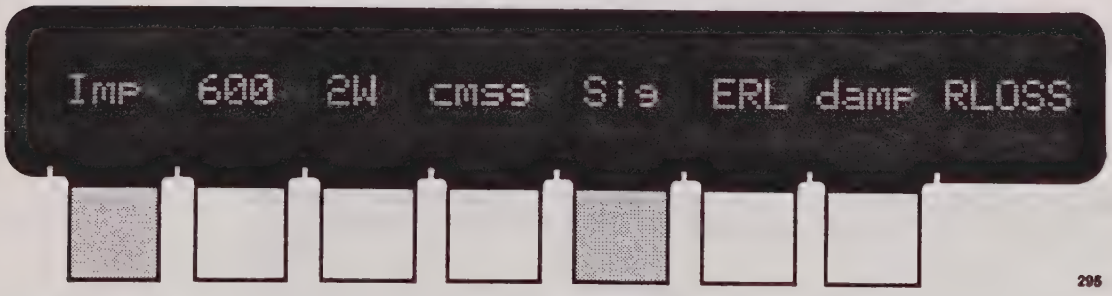


Figure 4-34. 2W Return Loss Setup Display

2W Reference Impedance Selection: If 2W has been selected, the reference impedance may be selected by pressing the second soft key to the right of IMP (see Figure 4-34).

4W/2W Selection: 2W return loss is selected by pressing the third soft key under 4W.

4W Transhybrid Loss Correction: If 4W is selected, the transhybrid loss may be entered for correcting the return loss reading by pressing the second soft key to the right of THL (see Figure 4-32). Use the keypad to enter the sign and then the numbers.

The impedance selections are 600, 900, or 1200 Ohms (each in series with 2.16 microfarads); or an external reference impedance which must be inserted into the NORM-RCV jack in the TEST LINES section of the front panel.

> *NOTE: During all 2W return loss measurements, except for connecting an external reference impedance, the NORM-RCV jack must be open (no connections). Failure to observe this requirement will cause errors in the measurements.*

Test Signal Selection: Select the desired test signal by pressing the soft key to the right of Sig. The selection toggles through SRLO, SRHI, ERL, and SINE.

- SRLO for low frequency singing point return loss
- SRHI for high frequency singing point return loss
- ERL for echo return loss
- SINE for sine wave return loss

If normal weighting is selected, a 60 Hz high-pass filter provides flat weighting with at least 20 dB loss at 60 Hz. For the ERL test signal, C-Message weighting is provided by adding a C-Message filter to the 60 Hz high-pass filter. To select weighting, first observe whether the display indicates CMSG or cmsg. If the display indicates CMSG, C-Message weighting is selected. If cmsg appears, normal weighting is selected. To change the selection, press the fourth soft key below the CMSG or cmsg characters.

Damping Selection: To select the standard response according to IEEE Std 743/Bell PUB 41009, press the seventh soft key under DAMP. The standard damping is true when damp is all uppercase letters; to return to the fast response, press the soft key again and it toggles off. When the standard damping is selected, the reading settling time is significant.

4.7.3.2 4W Return Loss Measurement

There are various definitions for the 4W return loss measurement. Refer to the following paragraphs and Figure 4-35 for information about these definitions.

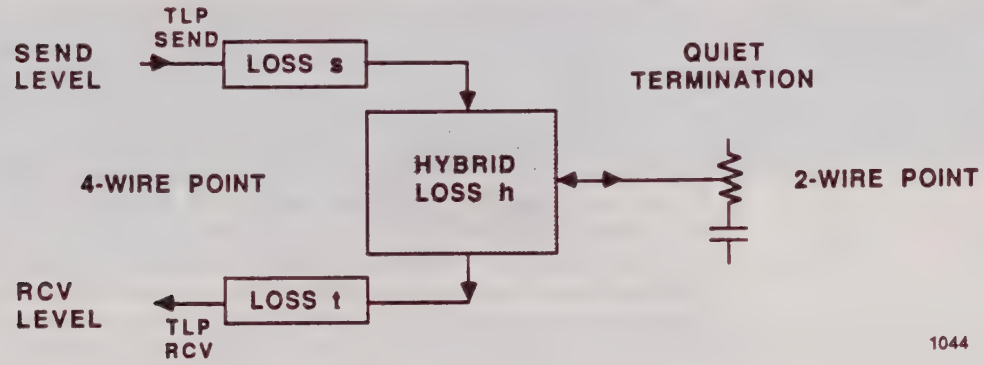


Figure 4-35. 4W Return Loss Measurement Diagram

Echo Path Loss (EPL): This is the send level of the weighted noise or sine wave minus the receive level at the 4W point. This measurement is displayed if the THL register in the SETUP display is 0.0 dB. Note that the 2W side must be properly terminated during this measurement.

Equal Level Echo Path Loss (ELEPL): This measurement takes the EPL measurement and corrects it for the particular send and receive TLPs at the 4W point. This value remains constant at different points along the 4W circuit.

$$ELEPL = EPL - TLP_{SEND} + TLP_{RCV}$$

This measurement is made by entering the difference of the send and receive TLPs in the THL register.

$$THL = TLP_{SEND} - TLP_{RCV}$$

Impedance Balance (ZB): The impedance balance is the Echo Path Loss, less the path losses in the 4W circuit and the hybrid loss, with a total mismatch (the 2W side open or shorted).

$$THL = EPL_0 + s + r + h$$
$$ZB + EPL - THL$$

where:

THL = transhybrid loss
EPL = echo path loss, 2W side properly terminated
EPL_0 = echo path loss, 2W side terminated in an open or short. (2W return loss + 0 dB) ZB = impedance balance
s = loss on the 4W send side
r = loss on the 4W receive side
h = hybrid loss with a total mismatch on the 2W side

The impedance balance measurement may be made by two methods:

- If coordination at the 2W end is available, then a two-step process is used. First, provide a short or open at the 2W point, and press the SET0 key in the return loss MEAS display. The value of EPL_0 is transferred to the THL register and appears in the SETUP display. Now restore the proper termination at the 2W point, and the impedance balance measurement appears in the return loss MEAS display.
- If coordination is not available at the 2W point, as is often the case, but the circuit parameters are known, the measurement may be made with just the EPL measurement. The THL is calculated and entered into the THL register in the return loss SETUP display by pressing the second soft key from the left, and using the keypad. The sign must be entered first, followed by the number in the range ±99.9 dB. The impedance balance measurement now appears in the return loss MEAS display. Note that the 2W side must be properly terminated. Do not press the SET0 soft key.

Reference: Notes on the BOC Intra-Lata Networks, TR-NPL000275, Issue 1, April 1986, P7-56

4.7.3.3 2W Return Loss Measurement

To perform a 2W return loss measurement, use the following procedure. First, activate the return loss option and select the desired return loss test signal, the desired damping, and the 2W reference impedance. If an external reference impedance is selected, it must be connected across the NORM-RCV jack. (Refer to the 2W reference impedance selection instructions in the return loss setup procedures.)

Connect the line under test to the NORM-SEND (2W) jack and then observe the return loss reading on the display. The distant end of the line under test must be properly connected to a quiet termination of the correct impedance.

4.7.3.4 Measurement Display

Receive Level Measurement: The receive level measurement is on the left end of the display. This selection is provided for operator convenience and to allow measurements where the far-end hybrid cannot be disturbed. Level is displayed in dBm, and can range from +10 to -80 dBm.

Test Signal/Sine-Wave Frequency: Next to the level display is the test signal selected, or as in the case of sine wave return loss, the send frequency in kHz. Figures 4-36 and 4-38 show the return loss measurement displays.

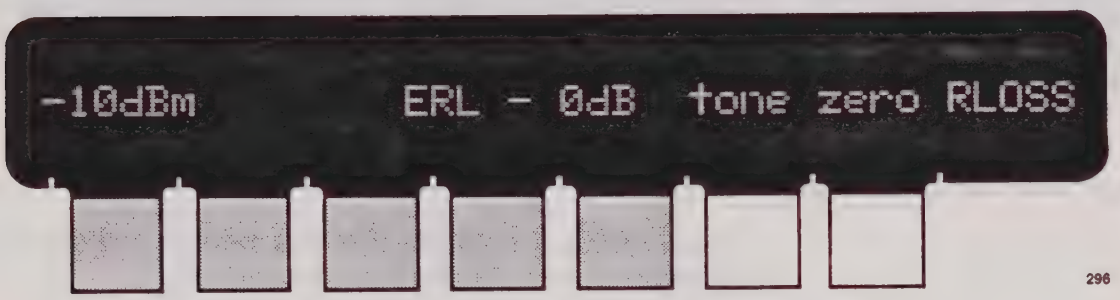


Figure 4-36. 4W Return Loss Measurement Display

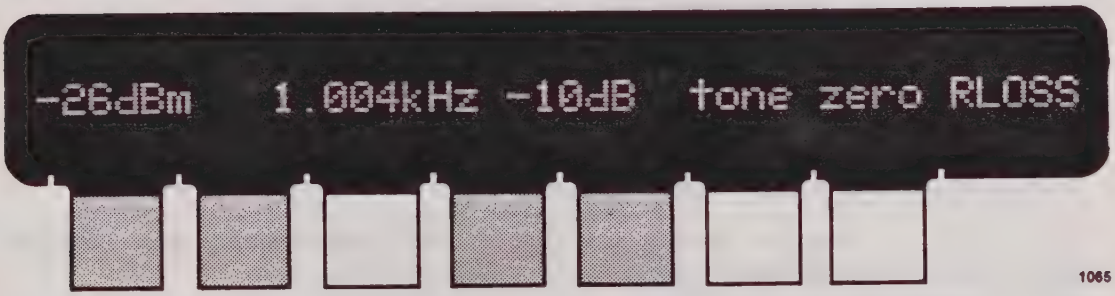


Figure 4-37. 4W Sine Wave Return Loss Measurement Display

Return Loss Measurement: To the right of the test signal selected is the return loss measurement display. Return loss is displayed in dB of loss.

Echo Suppressor Disable Tone Activation: When the return loss option is activated, or when the sixth soft key under TONE is pressed, a 2.15 kHz echo suppressor disable tone is transmitted for one second.

Zero Reference Set: For 4W measurements, with the return loss test signal applied to the circuit and the distant end hybrid disturbed, the transhybrid loss (THL) is set by pressing the seventh soft key under ZERO. The return loss display reads ± 0 dB. Then, when the hybrid is restored, the return loss reading is displayed. The THL register may be directly set in the SETUP display, without using the ZERO key, if distant end coordination is not available. The ZERO key is not present for 2W measurements.

4.7.4 Impulse Noise Measurements

Refer to Section 4.9 for instructions on performing impulse noise measurements.

4.8 PCM Testing

PCM testing is a two-step operation -- setup and measurement. Separate instructions are given for each of these operations. The instructions are further broken down according to the selected *mode* of operation (in-line, terminal, or DCS).

4.8.1 Setup Instructions for PCM Testing

Note: Before using the following instructions, be sure the PCM line-under-test is connected as described in Paragraph 4.4.2.

This section describes the procedure for setting up the CTS in the three modes of operation: In-Line, Terminal, and DCS. When the PCM LED on the PCM key is not lit, the PCM signal passes through the CTS in each direction undisturbed. You may completely set up the CTS before you turn on the PCM testing feature and avoid disturbing the transmission.

4.8.1.1 Operating Mode Selection

Note: After selecting an operating mode as described in this section, you can then use the setup instructions for the selected mode.

Pressing the PCM key in the MEASUREMENT section of the front panel causes PCM Setup Display 1 to appear as shown in Figure 4-38.

PCM Option Activation: The first two soft keys are used to activate and deactivate the PCM option. Pressing ON activates the option and lights the LED on the PCM key. Pressing OFF deactivates it, and restores the PCM stream to a pass-through configuration.

Operating Mode Selection: The next three soft keys are used to select the operating mode of the PCM option. The selections are:

- INLINE for testing in-service circuits. The unselected channels are passed through undisturbed.
- TRML (terminal) for looped testing of channel banks. The idle channel code (01111111) is transmitted to unselected channels.
- DCS for testing channelized circuits through a test access digroup (TAD) on a Digital Cross-connect System (DCS). The unselected ports are passed through undisturbed. (This permits daisy-chaining multiple CTSs on a single DCS TAD.)

PCM Interface Termination Selection: The sixth soft key under TERM (for terminate) will toggle the receive PCM termination from 100 ohms to bridging (>1000 ohms). In general, TRML should be used except when monitoring a circuit which is terminated by some other device.

Figure 4-38. In-Line PCM Setup Display 1

Normal/Advanced Testing Selection: Generally, tests are made in the NORM mode, which provides control and presentation of the commonly used PCM parameters. For extraordinary testing needs, the ADV selection is used to gain control of additional PCM parameters which are rarely needed in day-to-day testing. For normal testing, press the seventh soft key until NORM appears; for advanced testing, press the seventh soft key until ADV appears.

4.8.1.2 In-Line Mode Setup

Note: After completing the setup procedure, refer to Paragraph 4.8.2 for measurement instructions.

By pressing the SET UP key, additional PCM parameters and controls are set up from In-Line PCM Setup Display 2 or, if you selected the advanced mode, Advanced In-Line PCM Setup Display 2. The following paragraphs describe these displays.

In-Line PCM Setup Display 2: Figure 4-39 shows In-Line PCM Setup Display 2. This display appears if you selected the in-line and normal modes on In-Line PCM Setup Display 1 (Figure 4-37). Refer to the following descriptions of the selections available on this display. (Note that pressing the SET UP key again returns you to PCM Setup Display 1.)

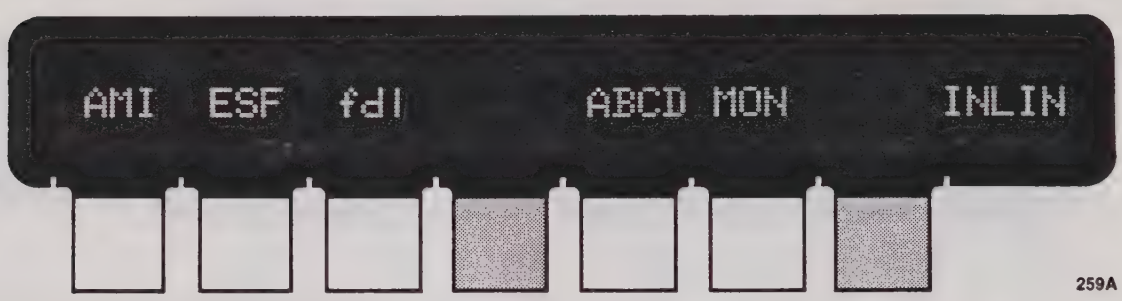


Figure 4-39. In-Line PCM Setup Display 2

Line Code Selection: The first soft key is used to select B8ZS or AMI.

- AMI coding does not guarantee an adequate number of 1 bits to assure proper PCM repeater operation (power-up default).
- B8ZS coding assures a minimum number of 1 bits by substituting a unique pattern of BPVs for any string of 8 zeroes. Needed for 64 kbps clear channel operation.

> *Note: The line code selection must properly match the line code of the circuit under test or errors (both bit and BPVs) may be injected into the signal in the in-line or DCS mode, monitor or drop-and-insert.*

Channel Format Selection: The second soft key permits the selection of common channel formats labeled by the compatible channel bank designations. The choices are D1D, D2, D3D4, ESF, and SLC-96™.

> *Note: The SLC-96™ format is supported only in the In-Line mode.*

Facility Data Link Drop-and-Insert Control: The third soft key is used to select through (fdl) or drop-and-insert (FDL) on the facility data link in the selected direction when extended superframe format (ESF) is selected. Refer to Section 5 to connect the facility data link. In through, the facility data link bits are passed through undisturbed.

Signaling Type Selection: The fifth soft key selects robbed-bit (A/B or ABCD), SF, or no signaling for the PCM channel. Pressing this soft key toggles the display between A/B or ABCD, SF and NONE.

Channel Monitor or Drop-and-Insert Selection: Pressing the sixth soft key toggles the unit between monitor and drop-and-insert operation.

- MON decodes the selected channel and its signaling in either direction. This is used for in-service PCM performance testing and does not disturb traffic or signaling on the channel. In monitor, BPVs that are received are retransmitted. In ESF, the 4 kbps facility data link may be monitored in both directions on the rear panel 9-pin RS-232-C connectors.

- D&I decodes the selected channel in either direction and encodes the CTS send side onto the channel in the direction selected. The channel in the opposite direction is encoded with idle channel code. The signaling for the channel, robbed- bit or SF, is under the direct control of the operator (refer to the DCS Measurement Display 2 discussion in Paragraph 4.8.2). This mode is used for out-service testing of the channel. In drop-and-insert, BPVs are removed.

- PTRN activates Option .65, if it is installed, and inserts the selected pattern onto the whole T1 stream if primary is selected or just on the selected channel if channelized is selected. Refer to Section 3.9.8 for further discussion of Option .65 operation.

Advanced In-Line PCM Setup Display 2

If the in-line *and* advanced modes are selected in PCM Setup Display 1 (Figure 4-37), the selections described in the previous section *and* an additional selection must be made. Figure 4-40, Advanced In-Line PCM Setup Display 2, shows these selections.

Alarm Mode Selection: The fourth soft key is used to select the "thru" or "tandem switch" alarm modes.

- THRU allows alarms to pass through undisturbed.

- TANDM simulates the response of a tandem office. If a red alarm is received, then AIS is sent downstream, and Remote Frame Alignment Alarm is sent upstream. The remote frame alignment alarm continues to be generated for 15 seconds after the red alarm condition ends. The red alarm is either NO PCM or a Frame Alignment Alarm.

Also, with in-line and advanced modes selected, an additional setup display, Advanced In-Line PCM Setup Display 3, is available. This display is described in the next section.

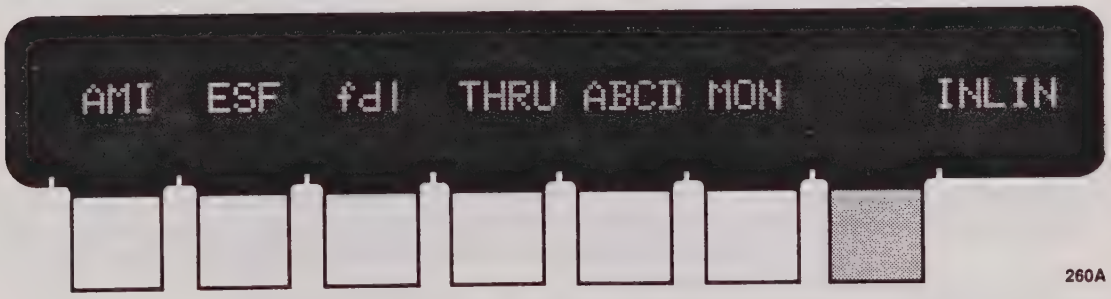


Figure 4-40. Advanced In-Line PCM Setup Display 2

Advanced In-Line PCM Setup Display 3

If the in-line *and* advanced modes are selected in PCM Setup Display 1 (Figure 4-37), Advanced In-Line PCM Setup Display 3 (Figure 4-41) is also available. If Advanced In-line PCM Setup Display *2* is displayed and you then press the SET UP key, Advanced In-Line PCM Setup Display *3* appears with the following selection:

Analog Source Selection: The seventh soft key selects the source and destination of the PCM encoded and decoded analog signals. If INT (internal) is selected, the encoded signal comes from the CTS internal generator, and the decoded signal is routed to the analog measurement circuitry.

If EXT (external) is selected, the encoded signal comes from the CTS TEST LINES VF NORM-RCV jack, and the decoded signal is transmitted on the CTS TEST LINES VF NORM-SEND (2W) jack. In the external mode, the CTS performs as a drop-and-insert box which may be used to connect external VF test equipment to a PCM channel.

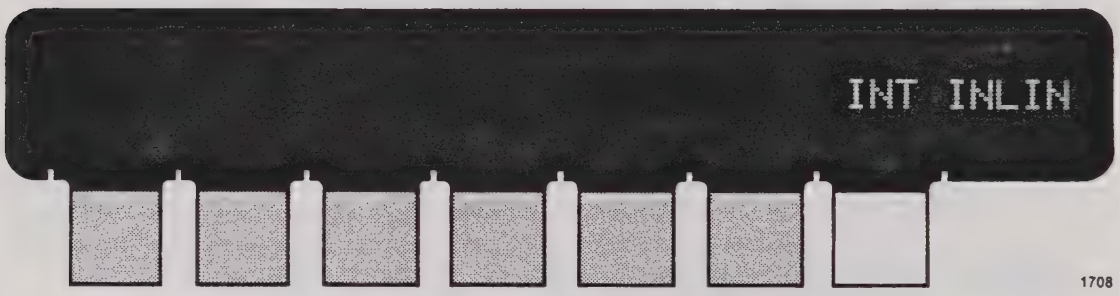


Figure 4-41. Advanced In-Line PCM Setup Display 3

4.8.1.3 Terminal Mode Setup

Additional PCM parameters and controls are set up from Terminal PCM Setup Displays 2 and 3 by pressing the SET UP key. Note that pressing the SET UP key repeatedly switches from PCM Setup Display 1 to Terminal PCM Setup Display 2 to Terminal PCM Setup Display 3.

In the Terminal Mode, the Facility Data Link is always in the drop-and-insert mode if the extended superframe format (ESF) is selected. With no connection to the rear plate, all 1s is transmitted unless the remote frame alignment alarm (yellow) is required. Refer to Section 5 for connection.

Terminal PCM Setup Display 2

Line Code Selection: The first soft key is used to select from B8ZS and AMI(see Figure 4-42).

- AMI coding does not guarantee an adequate number of 1 bits to assure proper PCM repeater operation (power-up default).
- B8ZS coding assures a minimum number of 1 bits by substituting a unique pattern of BPVs for any string of 8 zeroes. Needed for 64 kbps clear channel operation.

Figure 4-42. Terminal PCM Setup Display 2

Channel Format Selection: The second soft key permits the selection of common channel formats labeled by the compatible channel bank designations. The choices are D1D, D2, D3D4, and ESF.

Remote Alarm Delay Selection: The third soft key permits the delay from the receiving red alarm to the generation of remote alarm to be set to 0.3 or 2.6 seconds. Red alarm is NO PCM or frame alarm. The remote alarm continues to be generated for 15 seconds after the red alarm condition ends. Pressing the soft key toggles the display between the two selections.

Transmit Clock Source Selection: The fourth soft key allows the operator to have the transmit clock derived from the receive clock (SLAV), or from a local crystal-controlled clock (MSTR). The selection depends on which equipment the CTS must work with; if a system clock is available from the receive side, then it would normally be used (SLAV). If the CTS is simulating the transmission system into a channel bank, for example, then the local (MSTR) clock would be selected.

Signaling Type Selection: The fifth soft key selects robbed-bit (A/B or ABCD), SF, or no signaling for the PCM channel. Pressing this soft key toggles the display between A/B or ABCD, SF, and NONE.

Idle or Drop-and-Insert Selection: Pressing the sixth soft key toggles the unit between idle and drop-and-insert operation.

- IDLE transmits idle channel code on all channels. The selected channel receive is monitored for both signal and signaling. This selection is used for out- of-service PCM performance testing.

- D&I decodes the selected channel in either direction and encodes the CTS send side onto the channel in the direction selected. The channel in the opposite direction is encoded with idle channel code. The signaling for the channel, robbed- bit or SF, is under the direct control of the operator (refer to the DCS Measurement Display 2 discussion in Paragraph 4.8.2). This mode is used for out-service testing of the channel. In drop-and-insert, BPVs are removed.

- PTRN activates Option .65, if it is installed, and inserts the selected pattern onto the whole T1 stream if primary is selected or just on the selected channel if channelized is selected. Refer to Section 3.9.8 for further discussion of Option .65 operation.

Advanced Terminal PCM Setup Display 2

If the terminal and advanced modes are selected in PCM Setup Display 1, additional selections must be made. In the advanced terminal mode, the operator may independently control the transmit clock source, the alarm delay, and the drop-and-insert selection for the east and west directions. The controls being displayed are for the direction displayed under the seventh soft key. Refer to Figure 4-43, Advanced Terminal PCM Setup Display 2.

Figure 4-43. Advanced Terminal PCM Setup Display 2

Transmit Clock Source Selection: Same as normal mode, but in advanced mode it is independently set to MSTR or SLAV for each direction.

Channel Drop-and-Insert Selection: In the advanced mode, the drop-and-insert selection provides additional selections for the send PCM signal. This selection is independently set for each direction.

- IDLE transmits idle channel code on all channels. The selected channel receive is monitored for both signal and signaling. This selection is used for out- of-service PCM performance testing.

- D&I decodes the selected channel in either direction and encodes the CTS send side onto the channel in the direction selected. The channel in the opposite direction is encoded with idle channel code. The signaling for the channel, robbed- bit or SF, is under the direct control of the operator (refer to the DCS Measurement Display 2 discussion in Paragraph 4.8.2). This mode is used for out-service testing of the channel. In drop-and-insert, BPVs are removed.

- LOOP provides a loop-back of the PCM stream undisturbed in the direction selected. It is used to "keep alive" one direction while performing an out-of-service test in the opposite direction.

    - *Alarm Indication Signal (AIS)* causes the selected direction to be encoded with an unframed all 1s pattern in all channels.

    - *Remote Frame Alignment Alarm (RFALM)* causes the selected direction to be encoded with remote frame alignment pattern (all bit 2s set to 0 for superframe formats and bit oriented message on facility data link for ESF).

    - PTRN activates Option .65, if it is installed, and inserts the selected pattern onto the whole T1 stream if primary is selected or just on the selected channel if channelized is selected. Refer to Section 3.9.8 for further discussion of Option .65 operation.

Direction Selection: The seventh soft key is used to select the direction (EAST or WEST) for the transmit clock source, the alarm delay, and the drop-and-insert selection.

Terminal PCM Setup Display 3

Terminal Mode Test Type: The fourth and fifth soft keys toggle through the three Terminal Mode configurations. Refer to Figure 4-44.

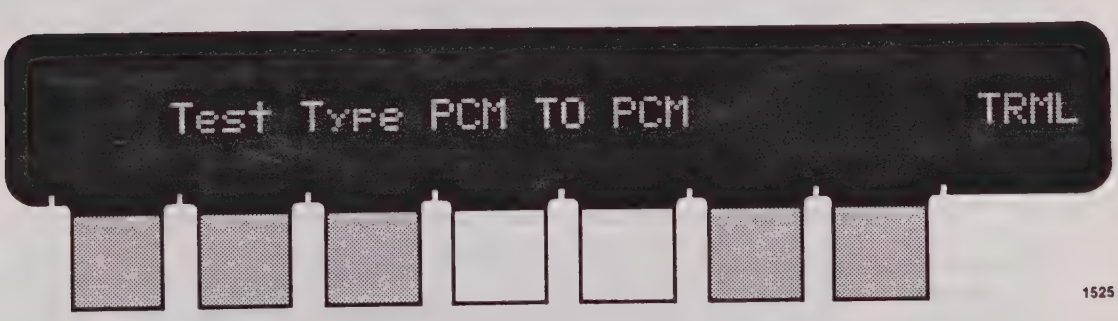


Figure 4-44. Terminal PCM Setup Display 3

- PCM to PCM provides for an all digital interface. This mode may be used to test the digital side of a channel bank, or to simulate a terminal device to a T1 transmission system.

- VF to PCM allows the test send side to originate from the CTS TEST LINES VF SEND jack. The receive is derived from the decoded selected channel from the selected TEST LINES PCM IN jack. This mode tests a channel banks encoding of an analog signal.

- PCM to VF encodes the test send signal onto the selected PCM channel. The receive comes from the CTS TEST LINES VF RCV jack. This mode tests a channel banks decoding of a digital signal.

Advanced Terminal PCM Setup Display 3

In the advanced terminal mode, Setup Display 3 includes the analog source selection. Refer to Figure 4-45.

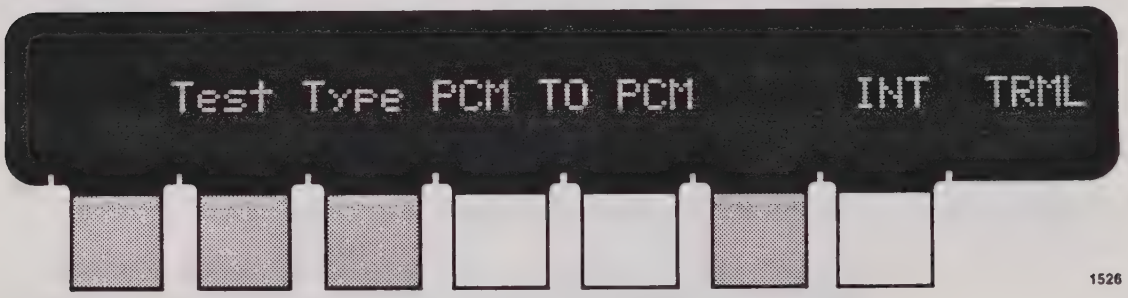


Figure 4-45. Advanced Terminal PCM Setup Display 3

Analog Source Selection: The seventh soft key selects the source and destination of the PCM encoded and decoded analog signals. If INT (internal) is selected, the encoded signal comes from the CTS internal generator, and the decoded signal is routed to the analog measurement circuitry. If EXT (external) is selected, the encoded signal comes from the CTS TEST LINES VF NORM-RCV jack, and the decoded signal is transmitted on the CTS TEST LINES VF NORM-SEND (2W) jack. In the external mode, the CTS performs as a drop-and-insert device which may be used to connect external VF test equipment to a PCM channel.

4.8.1.4 DCS Mode Setup

Additional PCM parameters and controls are set up from the DCS PCM Setup Display 2 and, if you selected the advanced mode, DCS PCM Setup Display 3.. These displays appear if PCM Setup Display 1 (Figure 4-37) is displayed and you then press the SET UP key. (This displays DCS PCM Setup Display 2; if you selected the advanced mode, pressing the SET UP key again displays DCS PCM Setup Display 3.) Both of these setup displays are described in the following paragraphs.

DCS PCM Setup Display 2

As shown in Figure 4-46, the following selections are available on DCS PCM Setup Display 2.

Figure 4-46. DCS PCM Setup Display 2

Line Code Selection: The first soft key is used to select from B8ZS and AMI.

- AMI coding does not guarantee an adequate number of 1 bits to assure proper PCM repeater operation (power-up default).
- B8ZS coding assures a minimum number of 1 bits by substituting a unique pattern of BPVs for any string of 8 zeroes. Needed for 64 kbps clear channel operation.

> *Note: The line code selection must properly match the line code of the circuit under test or errors (both bit and BPVs) may be injected into the signal in the In-Line or DCS mode, monitor or drop-and-insert.*

Framing Format Selection: The second soft key is used to select superframe (D3D4) format or extended superframe format (ESF) only.

Remote Alarm Delay Selection: The third soft key permits the delay from the receiving red alarm to the generation of the remote alarm to be set to 0.3 or 2.6 seconds. Red alarm is the NO PCM or Frame Alarm. The remote alarm continues to be generated for 15 seconds after the red alarm condition ends. Pressing the soft key toggle the unit between the two selections.

Facility Data Link Drop-and Insert Control: The fourth soft key is used to select through (fdl) or drop-and-insert (FDL) on the facility data link when extended superframe format (ESF) is selected. In the DCS mode, there is only one DS-1 stream connected, and therefore only one facility data link connector on the rear plate is used. Refer to Section 5 to connect to the facility data link.

Signaling Type Selection: The fifth soft key selects robbed-bit (A/B or ABCD) or single frequency (SF) signaling for the PCM channel. Pressing this soft key toggles the display between A/B or ABCD and SF.

Channel Monitor and Drop-and-Insert Selection: The sixth soft key toggles the unit between monitor and drop-and-insert operation.

- MON decodes the selected channel and its signaling in either direction. This is used for in-service PCM performance testing and does not disturb traffic or signaling on the channel. In monitor, BPVs that are received are retransmitted. In ESF, the 4 kbps facility data link may be monitored in both directions on the rear panel 9-pin RS-232-C connectors.

- D&I decodes the selected channel in either direction and encodes the CTS send side onto the channel in the direction selected. The channel in the opposite direction is encoded with idle channel code. The signaling for the channel, robbed- bit or SF, is under the direct control of the operator (refer to the DCS Measurement Display 2 discussion in Paragraph 4.8.2). This mode is used for out-service testing of the channel. In drop-and-insert, BPVs are removed.

- PTRN activates Option .65, if it is installed, and inserts the selected pattern onto the whole T1 stream if primary is selected or just on the selected channel if channelized is selected. Refer to Section 3.9.8 for further discussion of Option .65 operation.

Advanced DCS PCM Setup Display 3

In the advanced DCS mode, Advanced DCS PCM Setup Display 2, shown in Figure 4-47, includes the following selection.

Remote Alarm Delay Selection: In the advanced DCS mode, the third soft key permits the delay from the receiving red alarm to the generation of the remote alarm to be set to 0.3 or 2.6 seconds, or for no remote alarm to be generated by selecting NALM. Red alarm is NO PCM or Frame Alarm. For the 0.3 seconds and 2.6 seconds selection, the remote alarm continues to be generated for 15 seconds after the red alarm condition ends. Pressing the soft key rotates the display among the three selections.

Analog Source Selection: The seventh soft key selects the source and destination of the PCM encoded and decoded analog signals. If INT (internal) is selected, the encoded signal comes from the CTS internal generator, and the decoded signal is routed to the analog measurement circuitry. If EXT (external) is selected, the encoded signal comes from the CTS TEST LINES VF NORM-RCV jack, and the decoded signal is transmitted on the CTS TEST LINES VF NORM-SEND (2W) jack. In the external mode, the CTS performs as a drop-and-insert box which may be used to connect external VF test equipment to a PCM channel.

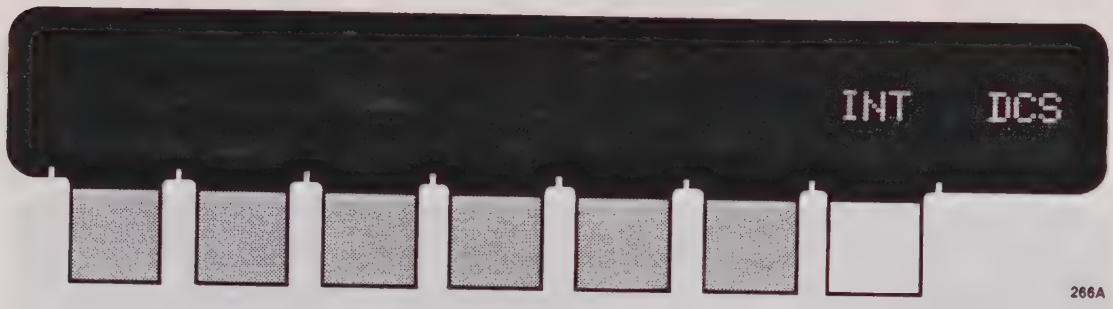


Figure 4-47. Advanced DCS PCM Setup Display 2

4.8.2 Measurement Instructions

The following paragraphs describe how to measure PCM parameters. Separate instructions are provided for in-line/terminal and DCS modes of operation.

4.8.2.1 PCM Measurement Displays (In-Line and Terminal Modes)

From the In-Line or Terminal PCM Setup Displays, you can access the following two PCM measurement displays by pressing the MEAS key:

- PCM Performance Measurement Display (for in-service T1 "pipe" testing)
  OR
- PCM Signaling and Control Display (for channelized T1 testing)

Subsequent presses of the MEAS key toggle the unit between the PCM Performance MEAS Display and the PCM Signaling and Control Display.

PCM Performance Measurement Display

PCM Performance Totalizers: The left-most area of the display (Figure 4-48) is the totalizer for the eight events and alarms which are accumulated. The maximum count is 9999, and the count is set to zero at the start of a timed test. The results remain available after a test is complete until a new test is initiated. Pressing the second or third soft key rotates the display through the totalizers. The events and alarms counted are listed as follows:

- Multiframe Bit Errors (MFAS ERROR) *(superframe only)*
- CRC Errors (CRC ERROR) *(ESF only)*
- Errored Seconds (ERRORED SEC)
- Remote Frame Alignment Alarms (REMOTE ALARM)
- No PCM Alarms (NO PCM ALARM)
- Bipolar Violations (BPVs)
- Frame Bit Errors (FRAME ERROR)

- Frame Alignment Alarms (FRAME ALARM)
- Excessive Zeroes (EXCESS 0s)

NOTE: If Option .65 is installed, the selected from" direction displays the bit error ratio measurement results, and the unselected direction displays the in-service PCM performance totalizers above.

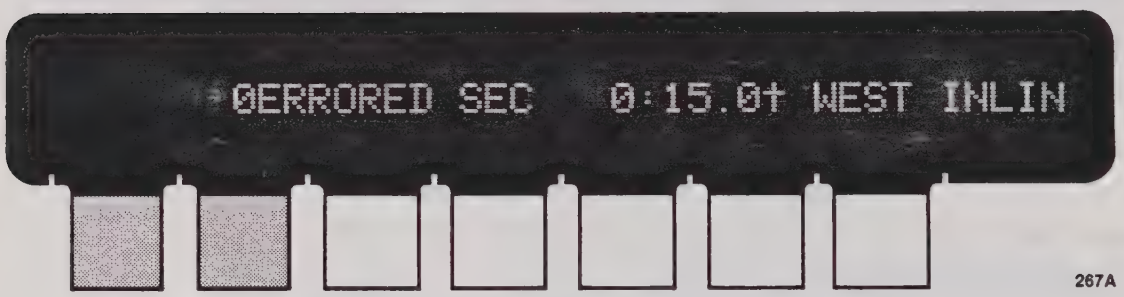


Figure 4-48. PCM Performance Measurement Display (In-Line or Terminal)

Timed Test Duration Set: The PCM performance test timer may be set for any duration from 0.1 minutes to 100 hours; it defaults to 15 minutes. To set the timer duration, press the fifth soft key, just to the left of the label t; _ _ _:_ _._ will appear. Enter the most through the least significant digits of hours, then minutes, and tenths of minutes using the keypad.

Timed Test Start/Stop: The PCM performance test timer is started and stopped by pressing the sixth soft key, directly under the label T. When the label is lowercase, the timer is stopped; when the label is uppercase, the timer is running. When the timer has timed out, the label reverts to lowercase, and the accumulated results and test duration are displayed.

Test Result Direction Selection: The performance tests are performed in both directions simultaneously. The seventh soft key allows you to display the results from the EAST or WEST.

PCM Signaling and Control Measurement Display (In-Line or Terminal Modes)

This display is used for channelized testing. It enables you to select a channel, test direction, and either robbed-bit or SF signaling parameters.

Figure 4-49. PCM Signaling and Control Measurement Display (ABCD Bit Signaling Version)

Channel and Test Direction Selections

Channel Number Selection: The first soft key permits the entry of the desired channel number from 1 to 24. Pressing the soft key replaces the channel number with two underlines. Using the keypad, enter the channel number's most significant digit of the two-digit number first. This is the channel number on which monitor and drop-and-insert, if selected, are performed.

Drop-and-Insert Direction Selection: The second soft key from the left is used to select the insert direction (east or west) if a drop-and-insert has been selected in the In-Line or Terminal PCM Setup Display 2 (refer to Paragraph 4.8.1). All lowercase letters indicate that monitor or idle is active, and all uppercase letters indicate that drop-and insert is selected. When a test direction is selected, the receive direction is automatically set to the same direction.

Robbed-Bit Signaling Selections

Manual Signaling Bit Setting: During a drop-and-insert, the signaling bits may be directly set in each direction using the third and fourth soft keys, see Figure 4-48. Press the soft key labeled E or W (for east or west), and two underlines appear. Use the keypad to enter a 0 or a 1 for the A bit first, then the B bit for superframe formats; and the A bit first, then the B, C, and D bits for ESF. These bits are transmitted when the direction labels are uppercase (D&I active). In monitor or idle, the signaling bits are passed through undisturbed, and the labels are lowercase, but the bits may be set up so that they are correct when a drop-and-insert is activated.

Receive Direction Selection and Receive Robbed-Bit Display: To the right of the manual signaling bit selections are two fields which permit the selection of the receive direction (east or west) and the display of the receive signaling bits or the receive alarm conditions of no PCM, frame alignment alarm, remote frame alignment alarm, or AIS (all 1s).

Pressing the fifth soft key selects the receive from the east direction. Pressing the last soft key selects the receive from the west direction. The selected receive direction is displayed by its label (E or W) being in uppercase. The signaling bits received from each direction are displayed following the receive direction label, starting with the A bit (0 or 1). If a receive alarm condition exists, it replaces the receive signaling field. The receive alarm conditions are denoted by the following labels:

- NOPCM for no PCM alarm
- FRALM for frame alignment alarm
- RFALM for remote frame alignment alarm
- AIS for alarm indication signal (All 1s)

SF Signaling Selections

Manual Signaling Control: During a drop-and-insert, SF supervision may be placed on the line in either or both directions using the third and fourth soft keys, see Figure 4-50. Pressing the soft key for east or west, labeled E or W, toggles SF between uppercase and lowercase. Uppercase means SF tone is transmitted, lowercase means no SF tone is transmitted. The tone or no tone is transmitted when the direction labels are uppercase. In monitor, the channel is passed through undisturbed, and the labels are lowercase, but the SF controls may be set up so that they are correct when a drop-and-insert is activated.

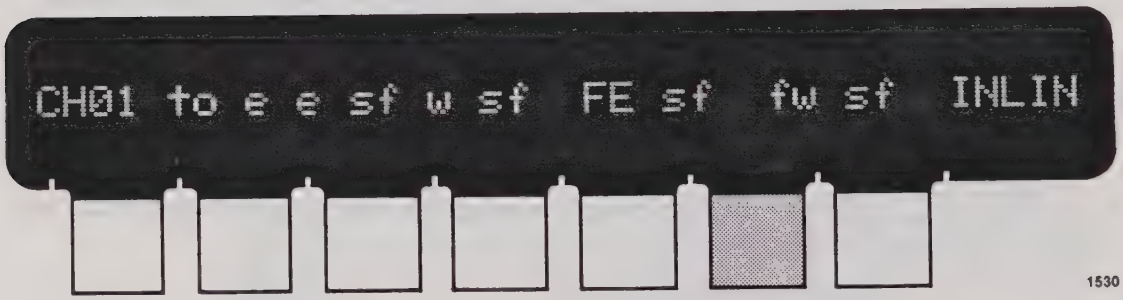


Figure 4-50. PCM Signaling and Control Measurement Display (SF Signaling Version)

Receive Direction Selection and Receive SF Display: To the right of the manual signaling control selections are two fields that permit the selection of the receive direction and the display of the receive SF status, or the receive alarm condition of no PCM, frame alignment alarm, remote frame alignment alarm, multiframe alignment alarm, remote multiframe alignment alarm, high frame bit error alarm, or alarm indication signal (all 1s). Pressing the fifth soft key selects the receive from the east direction.

Pressing the last soft key selects the receive from the west direction. The selected receive direction is displayed by its label (E or W) being in uppercase. The SF status of the direction is indicated by uppercase for tone detected and lowercase for no tone detected. If a receive alarm condition exists, it replaces the receive signaling field with one of the following labels:

- NOPCM for no PCM alarm
- FRALM for frame alarm
- RFALM for remote alarm
- AIS for alarm indication signal (All 1s)

4.8.2.2 PCM Measurement Displays (DCS Mode)

From the DCS PCM Setup Displays, you can access the two DCS measurement displays by pressing the MEAS key. Subsequent presses of the MEAS key toggles between the two displays. The first display is the DCS Performance Measurement Display (refer to Figure 4-51); the second is the DCS Signaling and Control Display (refer to Figure 4-51 for A and B bit signaling and Figure 4-52 for SF signaling).

PCM Performance Measurement Display (DCS Mode)

PCM Performance Totalizers: The left-most area of the display is the totalizer for the eight events and alarms which are accumulated. The maximum count is 9999, and the count is set to zero at the start of a timed test. The results remain available after a test is complete until a new test is initiated. Pressing the second or third soft key rotates the display through the totalizers. The events and alarms counted are listed below:

- CRC Errors (CRC ERROR) *(ESF only)*
- Multiframe Bit Errors (MFAS ERROR) *(superframe only)*
- Errored Seconds (ERRORED SEC)
- Remote Frame Alignment Alarms (REMOTE ALARM)
- No PCM Alarms (NO PCM ALARM)
- Bipolar Violations (BPVs)
- Frame Bit Errors (FRAME ERROR)
- Frame Alignment Alarms (FRAME ALARMS)
- Excessive Zeroes (EXCESS 0s)

> *NOTE: If Option .65 is installed, the selected from" direction displays the bit error ratio measurement results, and the unselected direction displays the in-service PCM performance totalizers above.*

Timed Test Duration Set: The PCM performance test timer may be set for any duration from 0.1 minutes to 100 hours; it defaults to 15 minutes. To set the timer duration, press the fifth soft key, just to the left of the label t; _ _ _:_ _._ will appear. Enter the most through the least significant digits of hours, then minutes, and tenths of minutes using the keypad.

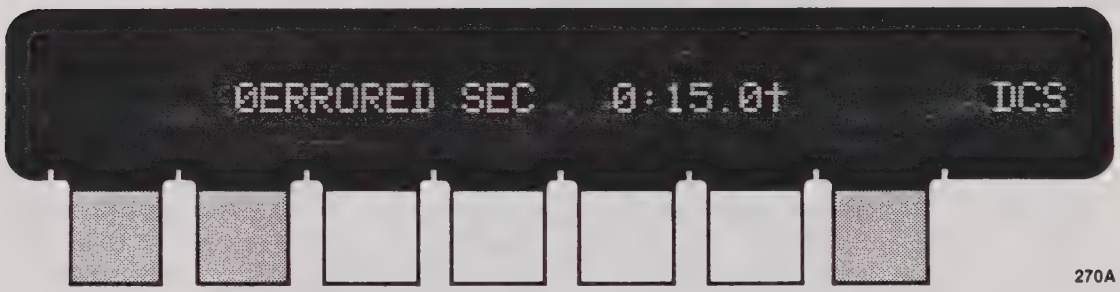


Figure 4-51. DCS PCM Performance Measurement Display

Timed Test Start/Stop: The PCM performance test timer is started and stopped by pressing the sixth soft key, directly under the label T. When the label is lowercase, the timer is stopped; when the label is uppercase, the timer is running. When the timer has timed out, the label reverts to lowercase, and the accumulated results and test duration are displayed.

DCS PCM Signaling and Control Measurement Displays

This display is used for channelized testing. It enables you to select a channel, test direction, and either robbed-bit or SF signaling parameters.

Figure 4-52. DCS PCM Signaling and Control Display (Robbed-Bit Signaling Version)

Port and Test Direction Selections

Test Port Number Selection: The first soft key permits the entry of the desired DCS test port from 1 to 12. Pressing the soft key replaces the DCS test port number with two underlines. Using the keypad, enter the test port number's most significant digit of the two-digit number first. This is the pair of adjacent channels on which monitor and drop-and-insert, if selected, are performed.

Drop-and-Insert Direction Selection: The second soft key from the left is used to select the insert direction (odd or even) if a drop-and-insert has been selected in the DCS PCM Setup Display 2 (refer to Paragraph 4.8.1). All lowercase letters indicate that monitor is active; all uppercase letters indicate that drop-and-insert is selected. When the test direction is selected, the receive direction is set to the same direction.

Robbed-Bit Signaling Selections

Manual Signaling Bit Setting: During drop-and-insert, the signaling bits may be directly set in each direction using the third and fourth soft keys, see Figure 4-52. Press the soft key for odd or even labeled O or E, and two underlines appear. Use the keypad to enter a 0 or 1 starting with the A bit first. These bits are transmitted when the direction labels are uppercase (D&I active). In monitor, the signaling bits are passed through undisturbed, and the labels are lowercase, but the bits may be set up so that they are correct when a drop-and-insert is activated.

Receive Direction Selection and Robbed-Bit Display: To the right of the manual signaling bit selections are two fields that permit the selection of the receive direction (odd or even), and the display of the receive signaling bits or the receive alarms. Pressing the fifth soft key selects the receive from the odd channel. Pressing the last soft key selects the receive from the even channel. The selected receive direction is displayed by its label (O or E) being in uppercase. The signaling bits received from each channel are displayed following the receive direction label starting with the A bit. If a receive alarm condition exists, it replaces the receive signaling field. The receive alarm conditions are denoted by the following labels:

- NOPCM for no PCM alarm
- FRALM for frame alignment alarm
- RFALM for remote frame alignment alarm
- AIS for alarm indication signal (All 1s)

SF Signaling Selections

Manual Signaling Control: During a drop-and-insert, SF supervision may be placed on the line of either or both channels using the third and fourth soft keys, see Figure 4-53. Pressing the soft key for odd or even, labeled O or E, toggles SF between uppercase and lowercase. Uppercase means SF tone is transmitted, lowercase means no SF tone is transmitted. The tone or no tone is transmitted when the direction labels are uppercase. In monitor, the channel is passed through undisturbed, and the labels are lowercase, but the SF controls may be set up so that they are correct when a drop-and-insert is activated.

Receive Direction Selection and Receive SF Display: To the right of the manual signaling control selections are two fields that permit the selection of the receive direction and the display of the receive SF status, or the receive alarm conditions.

Pressing the fifth soft key selects the receive from the odd channel. Pressing the last soft key selects the receive from the even channel. The selected receive direction is displayed by its label (O or E) being in uppercase. The SF status of the channel is indicated by uppercase for tone detected and lowercase for no tone detected. If a receive alarm condition exists, it replaces the receive signaling field with one of the following labels:

- NOPCM for no PCM alarm
- FRALM for frame alignment alarm
- RFALM for remote frame alignment alarm
- AIS for alarm indication signal (All 1s)

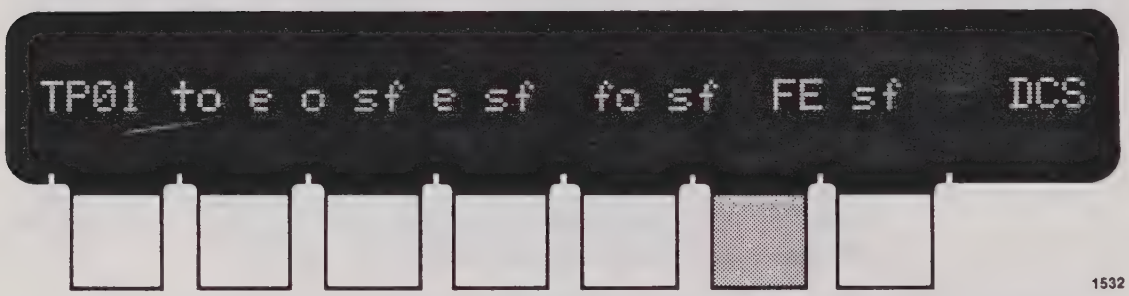


Figure 4-53. DCS PCM Signaling and Control Display (SF Signaling Version)

4.9 Optional Tests

This section contains instructions for performing measurements that are optional for 3700-series CTSs. To perform these measurements, the CTS must be equipped with the required option board.

> *NOTE: Some options are now included as standard equipment in all CTSs. Refer to Section 4.2.5 for instructions on how to determine what options are installed in the CTS.*

This section covers the following optional measurements:

- **Transients** - Requires Option .11, Three-Level Impulse Noise, and Option .13, Hits/Jitter for complete transients measurements.
- **Envelope Delay** - Requires Option .12 or .12A, Envelope Delay.
- **Jitter** - Requires Option .13, Hits/Jitter.
- **Intermodulation Distortion** - Requires Option .14 or .30, Intermodulation Distortion.
- **P/AR (peak-to-average ratio)** - Requires Option .18, .18A, or .30.
- **VOM/CAP** - Requires Option .40, VOMCAP.
- **Responder Interface Tests** - Requires Option .52, Responder Interface.
- **T1 Bit Error Ratio** - Requires Option .65, T1 Bit Error Ratio.

4.9.1 Transients (Option .11 and p/o .13)

This section describes the operating procedures for the transients measurements of Three Level Impulse Noise (Option .11), and gain hits, phase hits, and dropouts (part of Option .13). Three-Level Impulse Noise (Option .11) is standard in all 3700-series CTSs with Revision 12 or greater firmware. Option .13 also measures of phase and amplitude jitter.

The transients tests are the accumulation of transient events on the transmission circuit over a specified timer duration. The tests are designed to measure the occurrence of events which are likely to cause bit errors during data transmission by modems on a VF circuit. The options are designed to meet the specifications in Bell System Technical Reference PUB 41009.

The three-level impulse noise option measures and displays the number of times impulse noise (defined as any excursion of a band-limited signal above a preset threshold) occurs within a specified time period. The option is calibrated in dBrn to respond to the peak value of the received signal. Three thresholds are also provided. The low threshold is set from the ENTER keypad in 1-dB steps from 30 to 106 dBrn (40 to 106 for Option .10) with 15-kHz Flat, Program, 50-kilobit, or 50 kHz Flat filters (40 to 106 dBrn, Option .15, .15B, or .15C). High thresholds are determined by the spread, which is set from the keypad either to 2, 4, 6, or 8 dB.

The receive signal can be weighted by a C-Message filter or, with options, a 15-kHz Flat, Program, 50-kilobit, or 50 kHz Flat filter. A 1010 Hz test tone notch filter can also be selected.

The hits and dropouts measurements are performed on a channel with a 1-kHz holding tone. The measurement results are the timed total counts of phase hits, gain hits, and dropouts. The peak phase hit threshold is set from the keypad in 5 degree steps from 5 degrees to 50 degrees; the gain hit threshold is set in 1-dB steps from 1 dB to 10 dB, and the dropout threshold is 12 dB below the level of the receive holding tone. Phase and gain hits and dropouts must last for at least 4 milliseconds to qualify as valid counts.

The measurement timer is set from 1 to 60 minutes or continuous for longer tests. The receive level and frequency may be monitored during the test by pressing the LEVEL key. The impulse noise display is returned by pressing the IMPLS NOISE key. The impulse noise measurement may be made concurrently with hit and dropout measurements when an Option .13 is installed. Impulse noise counts are optionally interlocked with hits and dropouts to prevent extraneous counts.

During impulse noise measurements, the monitor signal is taken from the impulse noise threshold point that has been weighted by the noise filter and test tone notch, if selected. During hits measurements, the monitor signal is taken directly from the receive signal. The MONITOR VOL control may be used to adjust for input level variations.

Specifications for Options .11 and .13 are contained in Section 2.

4.9.1.1 Transients Setup Procedures

To perform a transients measurement, press the TRANSIENTS key in the MEASUREMENT section of the front panel, and the Transients Setup Display appears (see Figure 4-54).

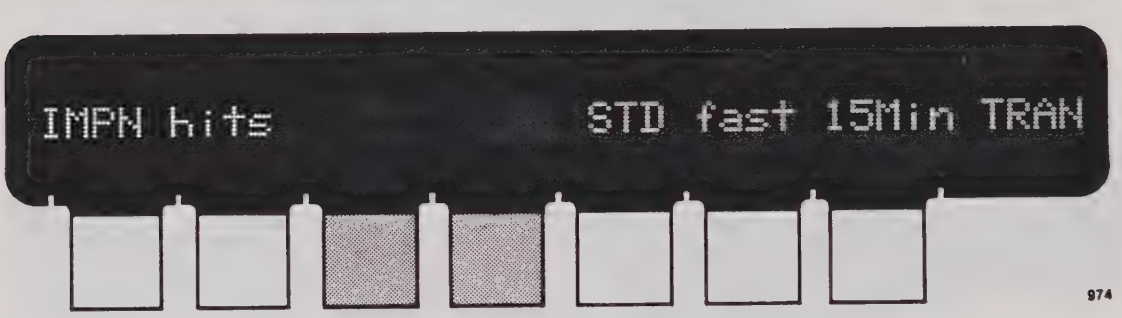


Figure 4-54. Transients Setup Display

Transients Test Selection: If an Option .13 Hits/Jitter is installed, the first two soft keys may be used to select impulse noise and/or hits measurements. Uppercase letters indicate a measurement is active.

Count Rate Selection: To select the Bell System standard count rate, press the soft key under STD. To select the fast count rate of 100 counts per second, press the soft key under FAST.

Timer Interval Entry: To set the measurement timer interval in minutes, press the soft key under MIN. All digits become underline characters. Enter an interval of 1 to 60 minutes, starting with the most to least significant digit. For continuous timer operation, enter any interval greater than 60 (i.e., 61 to 99); CONT appears where XXMIN was located.

4.9.1.2 Impulse Noise Setup Procedures

Press the SET UP key in the DISPLAY section of the front panel to show the Three-Level Impulse Noise Setup Display (see Figure 4-55).

Figure 4-55. Three-Level Impulse Noise Setup Display

Low Threshold Entry: To set the low threshold, press the soft key under the digits labeled dBrn. All digits become underlines. Using the ENTER keypad, enter the new threshold in the range of 30 to 106 dBrn (40 to 106 dBrn for Option .10; 40 to 106 dBrn with 15-kHz Flat, Program, 50-kilobit, or 50 kHz Flat filters; Option .15, .15B, or .15C) starting with the most significant digit.

Threshold Spread Entry: To set the low-to-mid and mid-to-high threshold spread, press the soft key under SPRD; it is replaced by an underline. Enter the new spread of 2, 4, 6, or 8 dB using the ENTER keypad.

Weighting Filter Selection: A 1010 Hz notch filter and the following weighting filters can be selected:

- C-Message
- 15-kHz Flat (requires Option .15, .15B, or .15C)
- Program (requires Option .15)
- 50-kilobit (requires Option .15B or .15C)
- 50 kHz Flat (requires Option .10 and .15C)

As indicated, some filter selections are available only if either Option .15, .15B, or .15C Noise Filters is installed in the CTS. Note that only one noise filter option may be installed in the CTS.

To select the weighting filter, press the SET UP key to display the Three-Level Impulse Noise Setup Display (shown in Figure 4-54). Then press the soft key located below the weighting filter selection characters ("CMSG" in Figure 4-54) until the desired characters are displayed. The filters that correspond to the filter selection characters are as follows:

- CMSG for C-Message
- 15FLT for 15-kHz Flat
- PRGM for Program
- 50KB for 50-kilobit
- 50FLT for 50 kHz Flat

4.9.1.3 Impulse Noise Measurement Display

Impulse Noise Totalizers: The three 4-digit count totalizers appear on the left side of the display (Figure 4-56). The totals continue to be displayed until reset to zero at the start of a new timed test.

Figure 4-56. Impulse Noise Measurement Display

Tone Loss Indicator: A flag message, NO TONE, showing that test tone has been interrupted, appears on the display if dropouts are not being counted. Test tone is 995 to 1025 Hz at +10 to -40 dBm. Once the test tone is interrupted, the flag remains displayed until a new test is started. If dropouts and hits are also being counted, the Tone Loss Indicator appears when the test tone drops out and disappears when the test tone returns.

Measurement Timer Controls: To initiate a timed test of impulse noise, or impulse noise and hits and dropouts, press the soft key under min. The test is started on the transition to MIN in uppercase letters. To stop a test, press the soft key again: MIN changes to lowercase and the measurement is terminated. When the test is completed or stopped, a long burst of the key sound tone appears on the monitor to alert the user. The current test results continue to be displayed until a new test is initiated.

4.9.1.4 Hits Setup Procedures

To set up the hits measurement, press the SET UP key in the DISPLAY section of the front panel (see Figure 4-57).

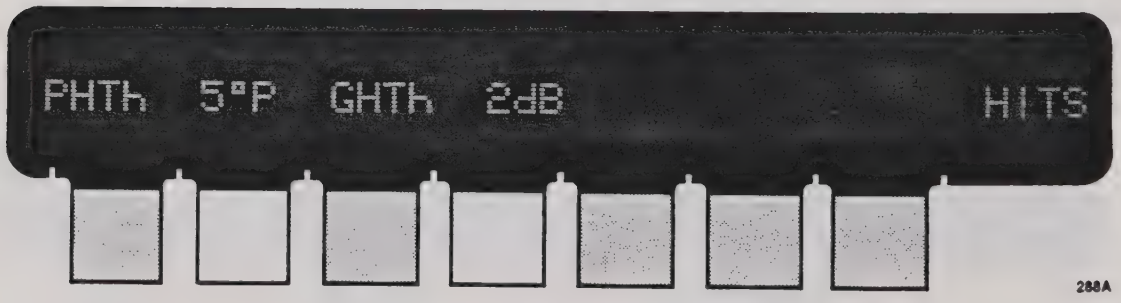


Figure 4-57. Hits Setup Display

Phase Hit Threshold Entry: To set the peak phase hit threshold, press the first soft key under P, and enter the threshold starting with the most then least significant digit. The threshold is set in 5-degree steps from 5 degrees to 50 degrees.

Gain Hit Threshold Entry: To set the gain hit threshold, press the third soft key under dB, and enter the threshold using the keypad. The threshold is set in 1-dB steps from 1 dB to 10 dB.

4.9.1.5 Hits Measurement Display

Hit and Dropout Totalizers: Three 4-digit count totalizers for phase hits, gain hits, and dropouts appear on the left side of the display. The totals will continue to be displayed until reset to zero at the start of a new timed test. Refer to Figure 4-58.

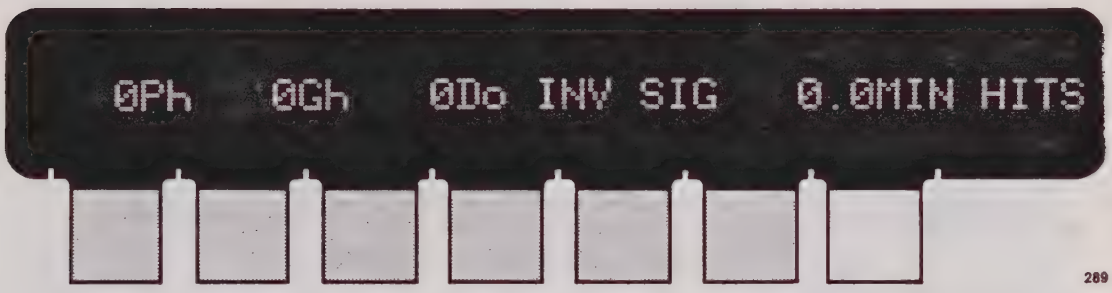


Figure 4-58. Hits Measurement Display

Caution Flag: At the start of a hits and dropouts test, if the receive test tone is outside the range of 995 to 1025 Hz or +10 to -40 dBm, the caution flag INV SIG appears following the totalizers. The flag remains latched until the start of a new test.

Measurement Timer Control: To initiate a timed test of hits and dropouts, or impulse noise and hits and dropouts, press the soft key under min. The test is started on the transition to MIN in uppercase letters. To stop a test, press the soft key again; MIN changes to lowercase and the measurement is terminated. When the test is completed or stopped, a long burst of the key sound tone appears on the monitor speaker to alert the user. The current test results continue to be displayed until a new test is initiated.

4.9.2 Envelope Delay (Option .12 or .12A)

This section describes how to measure envelope delay using Option .12 or .12A. Specifications are provided in Section 2.

> *NOTE: Option .12A is for use in units with Firmware Revision 12 or later. Option .12 may work in all units, but may require factory rework to function in units with Firmware Revision 12 or later.*

This option measures and displays envelope delay distortion. Designed to meet Bell System and IEEE standards, all measurement modes utilize 83-1/3 Hz modulation frequency and are compatible with WECO and other commercial sets with similar features. By using a unit at either end of the circuit, the master and slave modes can provide forward and return reference delay measurements. Direct loop measurements of

delay can be made with a single unit. To perform a delay measurement, press the DELAY key in the MEASUREMENT section of the front panel; configure the measurement according to the descriptions in the following paragraphs. During delay measurements, the MONITOR speaker obtains its signal directly from the receive side.

4.9.2.1 Forward Reference Delay Measurement Description

Figure 4-59 shows the configuration of a forward reference delay measurement. The master station sends reference frequency plus modulation; the slave station recovers the modulation and modulates its send carrier with this signal. The slave station send frequency is swept to obtain the amplitude and delay distortion information at the master station for the slave-to-master circuit.

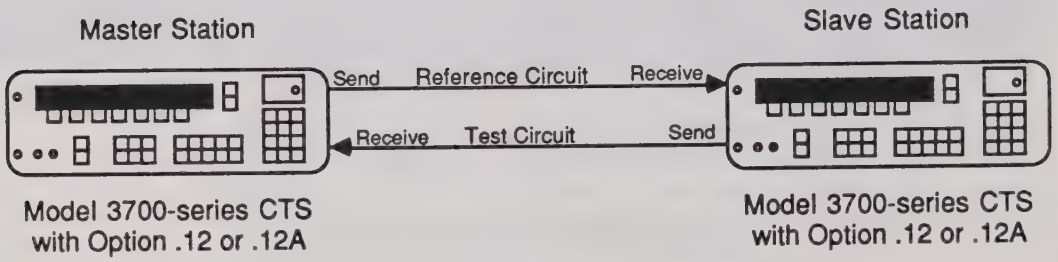


Figure 4-59. Forward Reference Delay Measurement

4.9.2.2 Return Reference Delay Measurement Description

Figure 4-60 shows the configuration of a return reference delay Measurement. The master modulates its send carrier with its internal modulation generator; the slave station recovers the modulation and modulates the reference frequency carrier on its send side. The master station send side is swept to obtain the delay distortion information at the master station for the master-to-slave circuit. Amplitude information may also be obtained at the master station if the amplitude repeat mode is selected at the slave station. The slave varies its send level to follow its receive level.

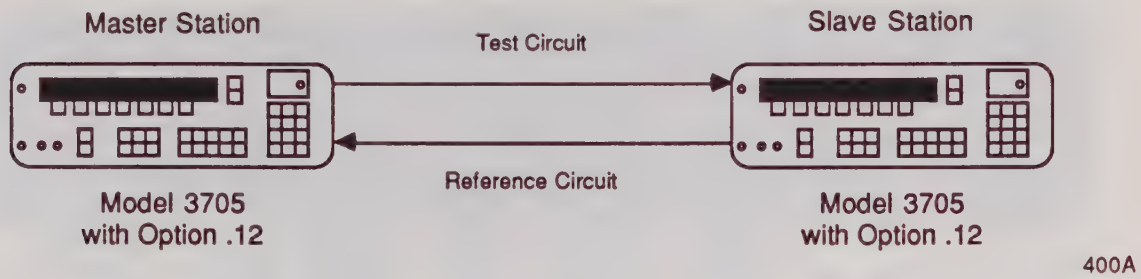


Figure 4-60. Return Reference Delay Measurement

4.9.2.3 Envelope Delay Setup Procedures

To perform an envelope delay measurement, press the DELAY key in the MEASUREMENT section of the front panel. Refer to Figure 4-61 when performing the following setup.

Master/Slave Mode Selection: If the unit is to collect the delay distortion data, press the first soft key under MSTR. If the unit is to aid in the collection of the delay distortion data at the distant end, press the second soft key under SLAVE.

Amplitude Repeat Selection: When SLAVE mode is selected and a return reference measurement is being made, pressing the third soft key under AMP permits amplitude distortion data as well as delay distortion data to be displayed at the master station. Uppercase indicates that amplitude repeat is active.

Receive/Send Frequency Selection: Either the receive or send frequency may be selected for display in the MEASUREMENT display. Pressing the fourth soft key under RCV or SEND toggles the display from one selection to the other. For return reference measurements, the master station should select SEND so that the measurement frequency is displayed, and the slave station should select RCV. For forward reference measurements, the master station should select RCV, and the slave station should select SEND.

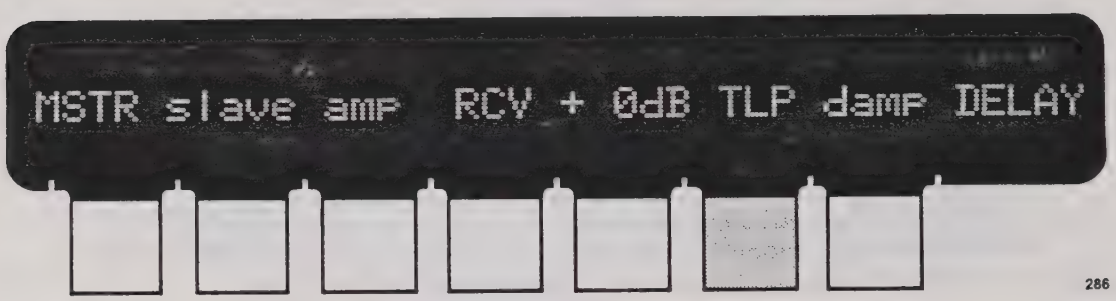


Figure 4-61. Envelope Delay Setup Display

TLP Entry: To enter a TLP for the level measurement, press the fifth soft key under the TLP digits; the digits will all be replaced by underlines. Enter a "+" or "-" sign, then the most through the least significant digits.

4.9.2.4 Display of Envelope Delay Measurement Results

The following paragraphs describe the Envelope Delay Measurement displays, shown in Figure 4-62.

Receive Level Measurement Display: The level measurement display is on the far left side of the display. The display range is +10.0 to -70.0 dBm for absolute level measurement. The units for the measurement are:

- dBm for absolute level measurements.
- dBm0 for level measurements relative to a TLP.
- dB for level measurements relative to a reference level.

Frequency Display: The frequency display follows the level measurement display and appears in kHz with a resolution of 1 Hz. The frequency display in kHz follows and shows the receive or send frequency as selected in the setup display. If the receive level is below -1.9 dBm, the digits of the frequency display are replaced by *.

Delay Measurement and Flags: The envelope delay reading in microseconds is to the right of the frequency display. The display has the range of -3000 to +9000 microseconds. If the receive signal has no 83-1/3 Hz modulation, the delay reading is replaced by INV SIG. If the receive signal is <-40 dBm or >+10 dBm, the delay reading is replaced by INV LEVEL.

Zero Reference Set: When functioning in the master mode, the seventh soft key under ZERO is pressed to set the delay reading to zero at the reference frequency.

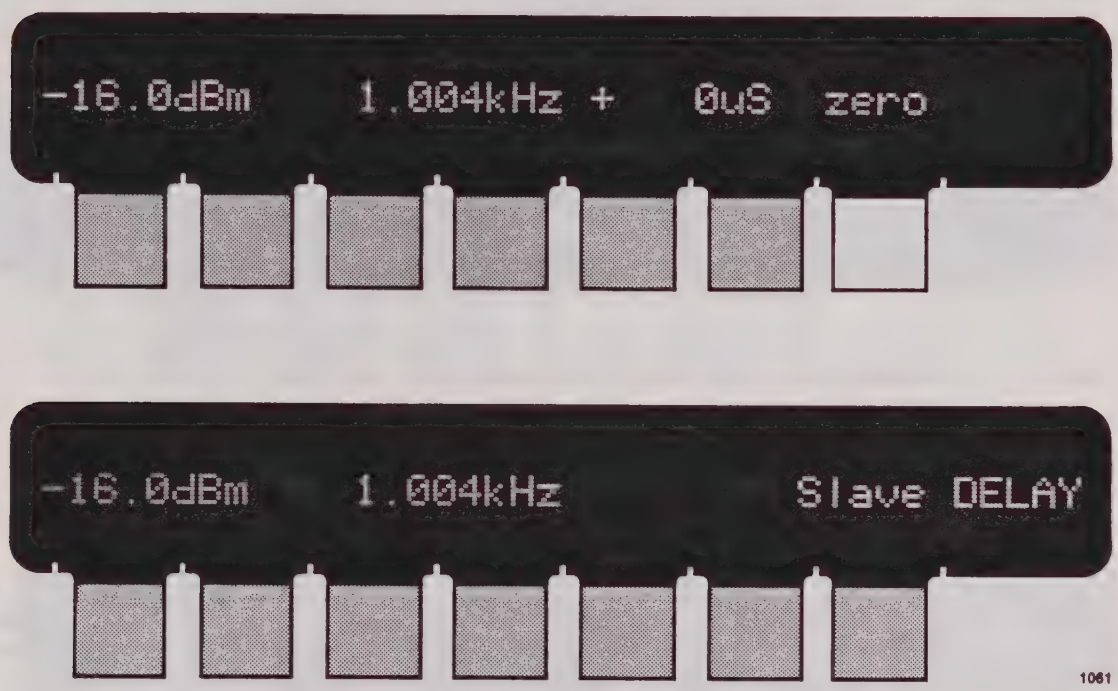


Figure 4-62. Envelope Delay Measurement Displays

4.9.3 Jitter (p/o Option .13)

This section describes the operating procedures for the test system Jitter Measurements using Option .13. (Refer to Section 2 for specifications.) This option provides measurements of phase hits, gain hits, dropouts, and phase and amplitude jitter.

Phase and amplitude jitter measurements are made on a 990 to 1030 Hz holding tone within a level range of +10 to -40 dBm. Phase and amplitude jitter may be measured with the standard weighting of 20 to 300 Hz (STD), or an extended low frequency weighting of 4 to 20 Hz (LF). The jitter measurements are made in the range of 0.0 to 30.0 degrees peak-to-peak for phase jitter and 0.0 to 30.0 percent peak for amplitude jitter. Overrange is indicated by all digits being replaced by +. A self-test send signal is provided to check the function of the phase and amplitude jitter measurements.

To perform a phase or amplitude jitter measurement, press the JITTER key in the MEASUREMENT section of the front panel. Using the soft keys, select phase or amplitude jitter and standard or standard + LF jitter range. Press MEAS to observe measurement results. The MONITOR obtains its signal directly from the receive side when JITR is displayed.

4.9.3.1 Jitter Setup Procedures

To perform a jitter measurement, press the JITTER key in the MEASUREMENT section of the front panel (refer to Figure 4-63).

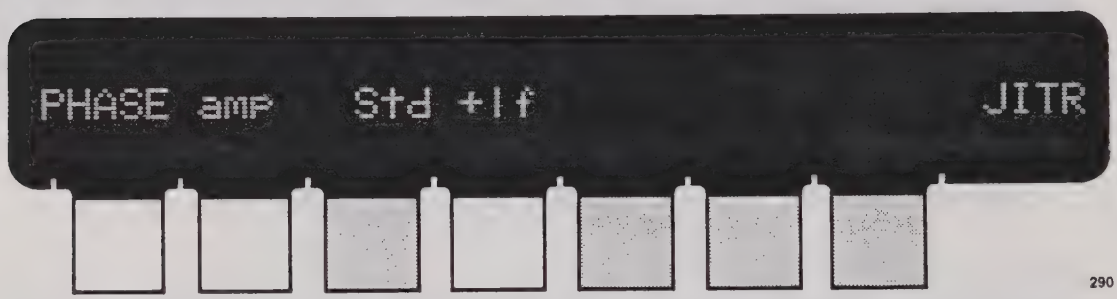


Figure 4-63. Phase Jitter Setup Display

Phase/Amplitude Jitter Selection: To select phase jitter measurements, press the first soft key under PHASE. To select amplitude jitter measurements, press the second soft key under AMP.

Jitter Frequency Range Selection: To select the extended low frequency range for jitter measurements, press the fourth soft key under LF. The extended range is selected when LF is all uppercase letters. To return to the standard 20 to 300 Hz range, press the soft key again to toggle LF off.

4.9.3.2 Jitter Measurement Display

Receive Level and Frequency Measurement: The left side of the display shows the receive level and frequency in dBm and kHz. For valid jitter measurements, the receive tone must be between +10 and -40 dBm and 990 to 1030 Hz.

Phase/Amplitude Jitter Measurement: Following the receive level and frequency is the phase or amplitude jitter measurement. Phase jitter is displayed from 0.0 to 30.0 degrees peak-to-peak and amplitude jitter from 0.0 to 30.0 percent peak. Refer to Figures 4-64 and 4-66 for these measurements.

Caution Flags: If the level is outside the range of +10 to -40 dBm, INV LEVEL replaces the jitter data. If the level is correct and the frequency is outside the range of 990 to 1030 Hz, INV SIG replaces the jitter data.

> *NOTE: The receive level is measured through the roofing filter centered around 1010 Hz. Level readings at other frequencies are weighted by this filter.*

Self-Test: To activate the self-test send signal, press the seventh soft key under TEST. This causes the generator to send a signal with 21.4 ±1.3 degrees peak-to-peak and 18.6 ±1.1% peak. Note that the send and receive sides must be looped back either at the jacks, or with a remote-control internal loop-back.

Figure 4-64. Phase Jitter Measurement Display

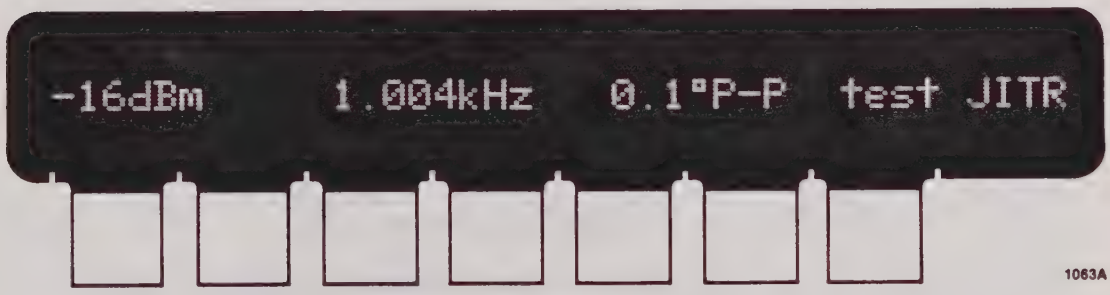


Figure 4-65. Amplitude Jitter Measurement Display

4.9.4 Intermodulation Distortion
(Option .14 and p/o Option .30)

This section describes the operating procedures for the test system intermodulation distortion measurements (Option .14 and part of Option .30). This option measures and displays second and third order intermodulation distortion. The option is designed to meet Bell System Technical Reference PUB 41009, IEEE Std 743-1984, and CCITT Recommendation O.42. The channel intermodulation distortion is measured using a 4-tone technique (Hekimian Patent No. 3,862,380). Tone pairs centered at 860 and 1380 Hz are applied to the channel at the distant end, and then the combination of the in-band second and third order intermodulation distortion products are measured and displayed.

The display is used also to show caution flags which are activated by the receive signal. If the receive signal is below -40 dBm or above 0 dBm, INV LEVEL is displayed.

If the receive signal is not a 4-tone test signal, SPURIOUS is displayed. If the receive signal contains just one tone pair, RCV S/N is displayed. The S/N (signal-to-noise) check signal is used to check that the product readings are not due to noise, but are the actual distortion products. This is accomplished by removing the lower tone pair and increasing the remaining tone pair by 3 dB; then on the receive end, the distortion readings are compared to those with the 4-tone signal. Table 4-2 shows the correction factor required to compensate for the effects of channel noise on the intermodulation distortion measurement. This must be done for both second and third order product readings. The monitor obtains its signal directly from the receive side when IMD is displayed. Also provided is a self-test send signal which has 35 dB second and third order products.

TABLE 4-2. INTERMODULATION DISTORTION MEASUREMENT CORRECTION FACTORS

If the S/N reading test is more than the intermodulation distortion reading by one of the values indicated below...	...Add the corresponding correction factor to the intermodulation distortion reading.
11 dB or greater	0
10	0.5
9	0.6
8	0.7
7	1.0
6	1.3
5	1.7
4	2.2
3	3.0
2	4.3
1	6.9
0	(Distortion reading is entirely due to noise)

4.9.4.1 Intermodulation Distortion *Setup Procedures*

There is no setup display for intermodulation distortion. To perform an intermodulation distortion measurement, press the IMD key in the MEASUREMENT section of the front panel.

4.9.4.2 Intermodulation Distortion *Measurement Display*

Receive Level Measurement: On the left side of the display (shown in Figure 4-66) is the receive level measurement result in dBm rms (root-mean-square). The receive level of the test signal must be in the range of 0 to -40 dBm for accurate measurements.

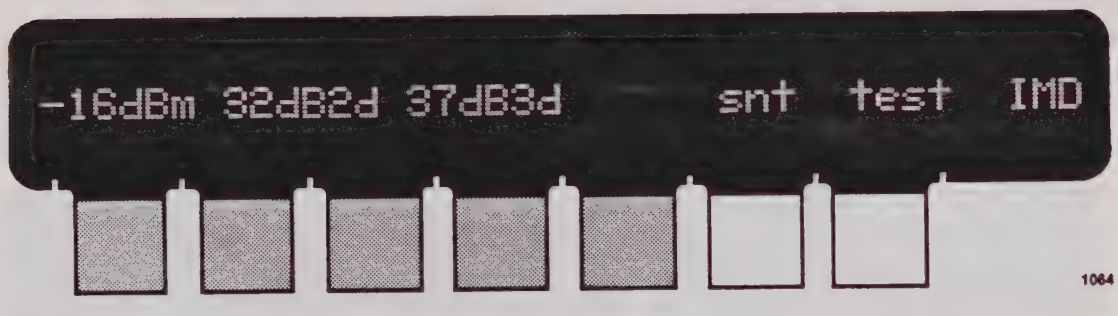


Figure 4-66. intermodulation distortion Measurement Display

Distortion Product Measurements: The second and third order distortion products are displayed in dB below the receive test signal. The readings. are in the range of +10 to +70 dB. When INV LEVEL and SPURIOUS are displayed, the product digits are replaced by **.

Caution Flags: The following caution flags are displayed in place of the distortion product readings, or in an area following the distortion product readings when certain receive conditions occur:

- INV LEVEL - a level out of the range of 0 to -40 dBm is being received.
- SPURIOUS - receive signal does not meet 4- or 2-tone S/N test signal requirements.
- RCV - A tone pair has been dropped for a receive S/N check.

S/N Check Activation: To activate the S/N check test signal on the send side, press the sixth soft key under SNT on the display. The S/N check is used to verify that actual distortion products are being measured and not noise, and to allow correction of the results for the effects of noise.

Self Test: To activate the self-test send signal, press the seventh soft key under TEST. This causes the generator to send a signal containing 35 dB of second and third order products. Note that the send and receive sides must be looped back either at the jacks, or with a remote-control internal loop-back.

4.9.5 P/AR (Option .18, .18A, and p/o .30)

This section describes the operating procedures for peak-to-average, P/AR, (Option .18, .18A, and .30) measurement. Option .18A and .30 may only be used in units with Revision 12 or greater firmware, Option .18 may be used in all units.

This option is designed to perform P/AR (peak-to-average ratio) measurements in accordance with Bell System Technical Reference PUB 41009 and IEEE Std 743-1984. The option includes a generator which produces the specified spectrum of 16 frequency components. The option is compatible with other P/AR measurement equipment meeting

current Bell System specifications. The P/AR measurement is designed to show the effects of envelope delay distortion, amplitude distortion, and poor return loss on voiceband data signals.

The receive side of the P/AR system weights the receive signal, and then measures the absolute peak value and the average value of the receive spectrum. Their ratio is displayed on a zero-suppressed scale. A P/AR signal experiencing no distortion displays 100 P/AR units. Actual measurement results are displayed in the range of 0 to 120 P/AR units. A self-test signal is provided which should read 59 P/AR units.

A DAMP soft key is provided to reduce reading fluctuations if desired. This is accomplished by displaying a running average of eight P/AR readings. The monitor obtains its signal directly from the receive side when P/AR is active.

4.9.5.1 P/AR Setup Procedures

To perform a P/AR measurement, press the P/AR key in the MEASUREMENT section of the front panel, see Figure 4-67. Apply the P/AR send signal at the distant end.

Damping Selection: To reduce fluctuations in the P/AR measurement readings, a running average of eight samples may be selected by pressing the seventh soft key under DAMP. When DAMP is all uppercase letters, it is active; pressing the soft key again toggles it off. This damping does not change the level reading response.

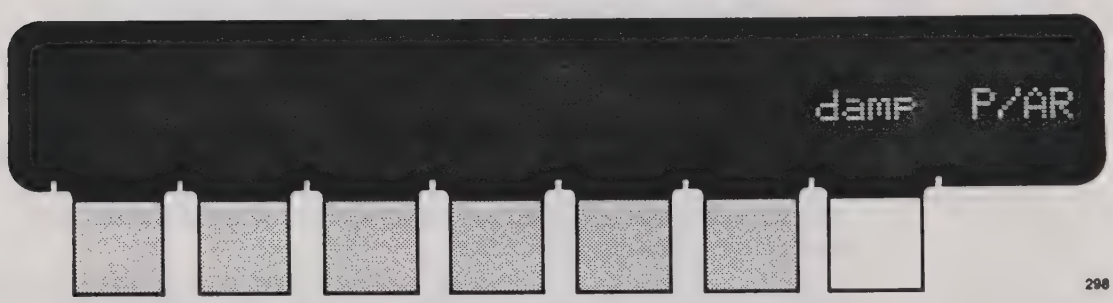


Figure 4-67. P/AR Setup Display

4.9.5.2 P/AR Measurement Display

Receive Level Measurement: The left side of the display shows the receive level in dBm rms, see Figure 4-68. The P/AR measurement has a valid receive level range of 0 to -40 dBm.

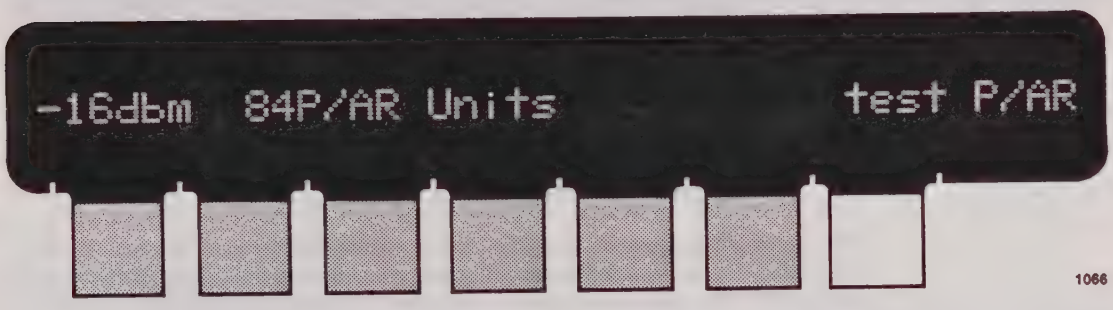


Figure 4-68. P/AR Measurement Display

P/AR Measurement: Following the level display is the P/AR measurement display, P/AR is measured in P/AR units, from 0 to 120. Underrange is indicated by replacing the digits with "-" signs, and overrange is indicated by "+" signs.

Invalid Level Flag: If the receive level is below -40 dBm or above -0 dBm, INV LEVEL is displayed following the P/AR measurement display.

Self-Test: To activate the self-test send signal, press the seventh soft key under TEST. This causes the generator to send a modified P/AR signal which should read 59 P/AR units. Note that the send and receive sides must be looped back either at the jacks or with a remote-control internal loop-back.

4.9.6 VOM/CAP (Option .40)

This section describes the operating procedures for the VOM/CAP Option .40. With Option .40 VOM/CAP, ac and dc voltage and current, resistance, and capacitance can be measured. In general, a telephone line has the combined characteristics of resistance, capacitance, and inductance. These characteristics interact so that resistance has an effect upon capacitance measurements, and capacitance has an effect upon resistance measurements. Option .40 uses a sampled data system as the measurement technique. This technique offers a compromise in minimizing the effect of this interaction on measurement accuracy. In addition, this sampled data system technique greatly reduces the effects of foreign voltage and background interference on resistance and capacitance measurements.

Access to the Option .40 is through the NORM-SEND (2W) jacks or corresponding rear panel terminals. Measurements may be made tip-to-ring, tip-to-sleeve, or ring-to-sleeve of the jacks. The line reversal function NORM/REV allows transfer of the connections to the NORM-RCV jack or corresponding rear panel terminals. Always activate the VOM/CAP option before connecting the line to be measured, and disconnect the line before entering any other test system measurement mode.

> **CAUTION: Although the Option .40 is designed to accurately measure high ac and dc voltages (200 Vdc and 160 Vac), these voltage levels cannot be tolerated in any other measurement mode of the test system. Except as defined in the specifications, it is not designed to withstand long duration, high voltage, or low impedance ac and dc sources. Application of levels in excess of the normal measurement range (+10 dBm) may result in damage to the test system.**

When making measurements using the Option .40, the measurement sequence should always start with voltage and current measurements, then proceed with resistance or capacitance measurements. If voltage or current measurements indicate overrange or overload, resistance and capacitance measurements should not be attempted. Although the test system will not be damaged, the results may not be meaningful and can result in a blown fuse on the Option .40 printed circuit board.

When the Option .40 initiates a capacitance measurement, it first places a momentary short across the line to discharge the capacitance and minimize the effects of foreign voltage. For this reason, Vdc, Vac, mAdc and mAac measurements should always be made in this sequence prior to making a capacitance measurement.

In all measurements, overrange in a positive direction is indicated by four plus signs (++++), and overrange in a negative direction is indicated by four minus signs (----). In resistance and capacitance measurements, if a valid reading cannot be made, four asterisks (****) will replace the reading digits. In current measurements, an overload is indicated by four asterisks and a current overload message. The current overload message is shown in Figure 4-69.

This overload condition opens the internal current shunt to protect the instrument, and can be reset only by going to the setup mode and then back to the measurement mode. When a large overload results in a blown fuse, the current and capacitance measurement displays will show BAD FUSE in the normal digits display. The internal fuse, Bussman GMT type 1-1/3A (white tab), located on the top edge of the Option .40 printed circuit board, must then be replaced.

> **CAUTION: For protection against fire, replace only with fuse of the specified type, voltage, and current ratings.**

Specifications for Option .40 VOM/CAP measurements are contained in Section 2.

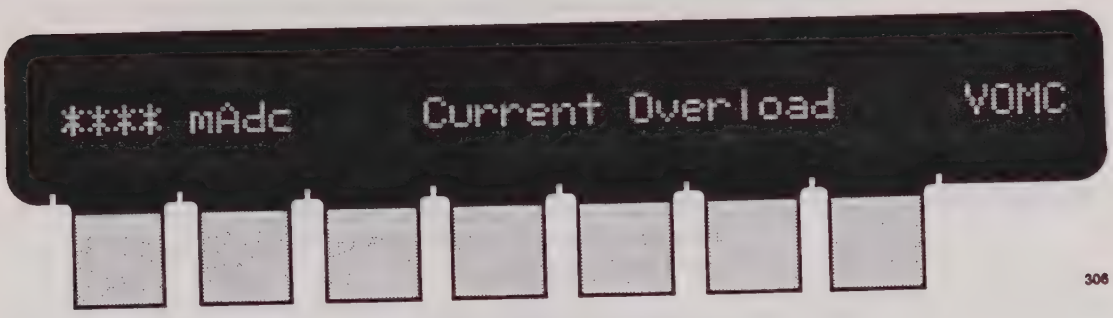


Figure 4-69. Current Overload Display

4.9.6.1 Setup Procedures

This section describes the setup procedures and measurement sequence to be used when making voltage, current, resistance, or capacitance measurements. To set up VOM/CAP (volt, ohms, milliamperes/capacitance) measurements, preform the following procedure.

Press the VOMC key in the MEASUREMENT section of the front panel. The unit now displays the VOMC SETUP display as shown in Figure 4-70. The default measurement is dc voltage. Press the soft key under the desired measurement mode.

The unit displays the measurement mode in uppercase letters. Press the MEAS key in the DISPLAY section of the front panel. The MEAS display and measurement results appear. To change the measurement mode, return to the SETUP display by pressing the SETUP key in the DISPLAY section of the front panel.

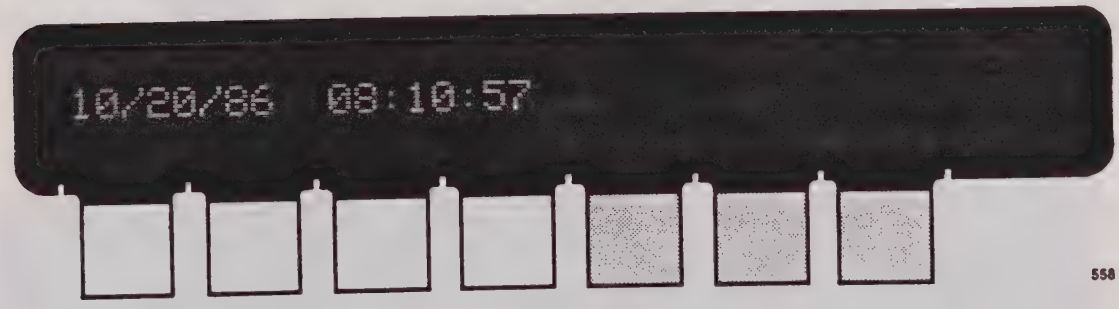


Figure 4-70. VOM/CAP Setup Display

4.9.6.2 Voltage and Current Measurements

To make voltage or current measurements, refer to Figures 4-71 through 4-74, and proceed as follows.

Perform the setup procedures described in the previous section, press the soft key under the desired connection. The default value is T-R, Tip to Ring.

> *NOTE: This selected connection is common to all measurements, and will only be reset to the default value by leaving the VOMC measurement mode. The connection can be changed in any of the VOMC MEAS displays.*

When NORM is displayed, connect the line under test to the NORM SEND jack in the TEST LINE section of the front panel. When REV is displayed, connect the line under test to the NORM RCV (REV SEND) jack in the TEST LINES section of the front panel. Press the soft key under NORM or REV to toggle between the normal line connection and the reverse line connection. The default value is NORM. The measurement results are displayed to three significant digits at the left of the measurement units.

To change measurement mode, return to the SETUP display by pressing the SETUP key in the DISPLAY section of the front panel.

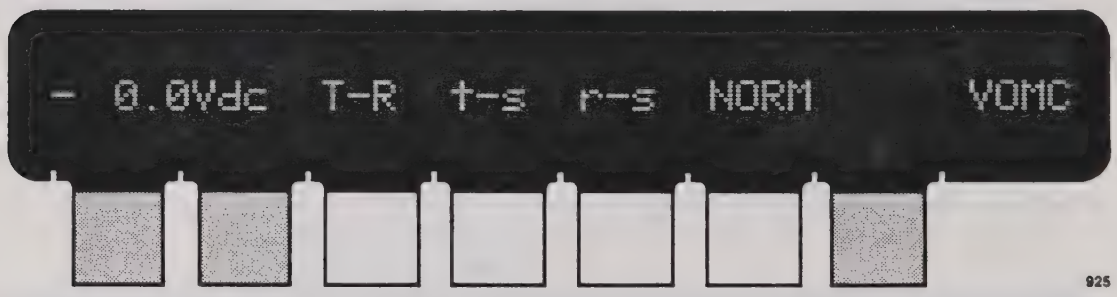


Figure 4-71. Volts dc Measurement Display

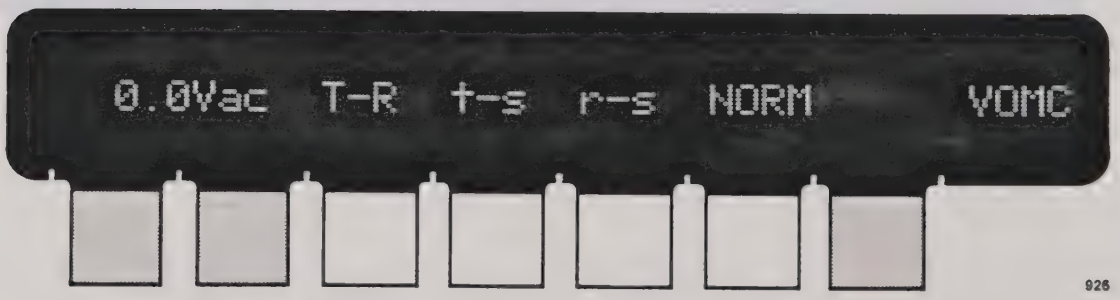


Figure 4-72. Volts ac Measurement Display

Figure 4-73. Milliamperes dc Measurement Display

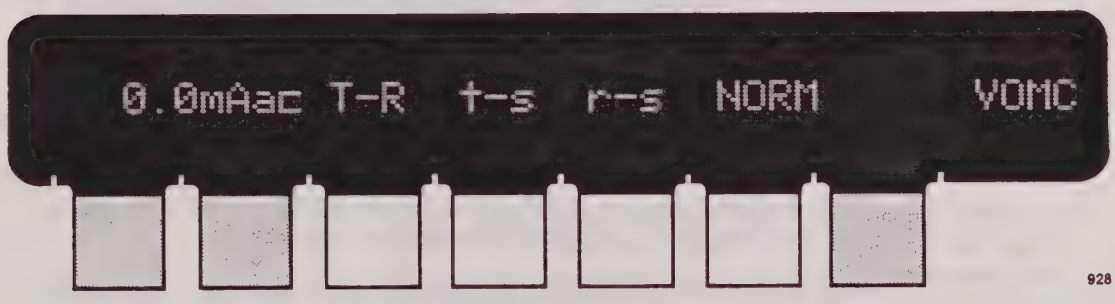


Figure 4-74. Milliamperes ac Measurement Display

4.9.6.3 Resistance Measurements

Resistance measurements are made using a sampled data technique. The Option .40 measures a change in voltage and the corresponding change in current, and calculates the indicated resistance value. This technique reduces the effect of foreign voltage. The actual value of foreign voltage that can be tolerated depends upon the resistance and the capacitance of the line under test.

Since this option uses a sampled data system, large amounts of capacitance can cause an apparent resistance reading. However, this measurement technique is an excellent compromise, and provides some immunity to the effects of foreign voltage.

There are two measurement ranges, a normal range and HIGH range, used with resistance measurements. The HIGH range extends the upper limit from 2.0 megohms to 20.0 megohms. The HIGH range increases the time to make a measurement by a factor of four. It is, therefore, more susceptible to changes in foreign voltage during this measurement time. This high range is useful for leakage tests, but it is recommended that the normal range be used for values below 2.0 megohms.

To make resistance measurements, refer to Figure 4-75 and proceed as follows.

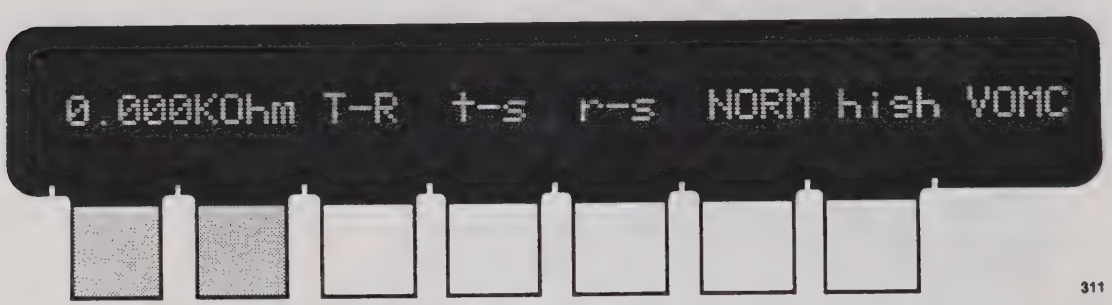


Figure 4-75. Resistance Measurement Display

CAUTION: During operation, a 100 Vdc source is applied periodically through approximately 100 kilo ohms to the line under test. A high residual voltage may be left on a capacitance being measured.

Perform the voltage and current measurements described in paragraph 4.9.6. Verify that the indicated values are within the normal measurement range. Press the SETUP key in the DISPLAY section of the front panel. Press the soft key under res. The unit displays RES. Press the MEAS key in the DISPLAY section of the front panel. The MEAS display appears. Verify the selected connection and input jack.

Press the soft key under high/HIGH to select the desired range. The measurement results are displayed to three significant digits at the left of the measurement units.

To change measurement mode, return to the SETUP display by pressing the SETUP key in the DISPLAY section of the front panel.

4.9.6.4 Capacitance Measurements

The Option .40 measures a change in charge and the corresponding change in voltage, and calculates the indicated capacitance value.

Integration and sampling methods are used to provide rejection at 50 Hz and 60 Hz, and some immunity to the effects of foreign voltage. Since the Option .40 uses a sampled data system, resistance can cause an apparent capacitance reading. However, this measurement technique is an excellent compromise and provides rejection to 50 Hz and 60 Hz. The method used is equivalent in many ways to the familiar ballistic or "meter kick" method commonly used to measure the capacitance of telephone lines.

There should be little or no dc voltage on the line during capacitance measurements. When the measurement is initiated, the line is discharged by placing a momentary short across the line. It is recommended that voltage and current measurements be made prior to making capacitance measurements.

There are two measurement ranges, a normal range and a HIGH range, used for capacitance measurements. The HIGH range extends the upper limit from 5 microfarads to 20 microfarads. This HIGH range increases the time to make a measurement by a factor of four. Therefore, it is more susceptible to change in foreign voltage or background interference during the measurement interval. It is recommended that the normal range be used for values below 5 microfarads.

To make capacitance measurements, refer to Figure 4-76 and proceed as follows.

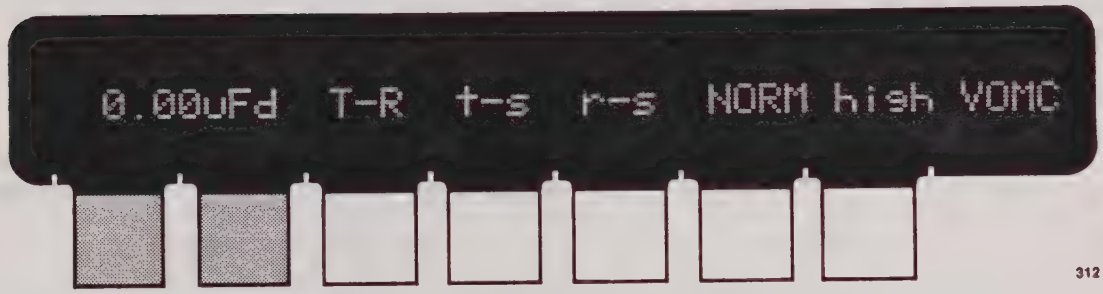


Figure 4-76. Capacitance Measurement Display

CAUTION: During operation, a 100 Vdc source is applied periodically through approximately 100 kilo ohms to the line under test. A high residual voltage may be left on a capacitance being measured.

Verify that the indicated values are within the normal measurement range. Press the SETUP key in the DISPLAY section of the front panel.

NOTE: When a capacitance measurement is initiated, the line under test is discharged by placing a momentary short across the line. There should be no dc voltage on the line when making capacitance measurements.

Press the soft key under cap. The unit displays CAP. Press the MEAS key in the DISPLAY section of the front panel. The MEAS display appears. Verify the selected connection and the input jack. Press the soft key under high/HIGH to select the desired range. The measurement results are displayed to three significant digits at the left of the measurement units.

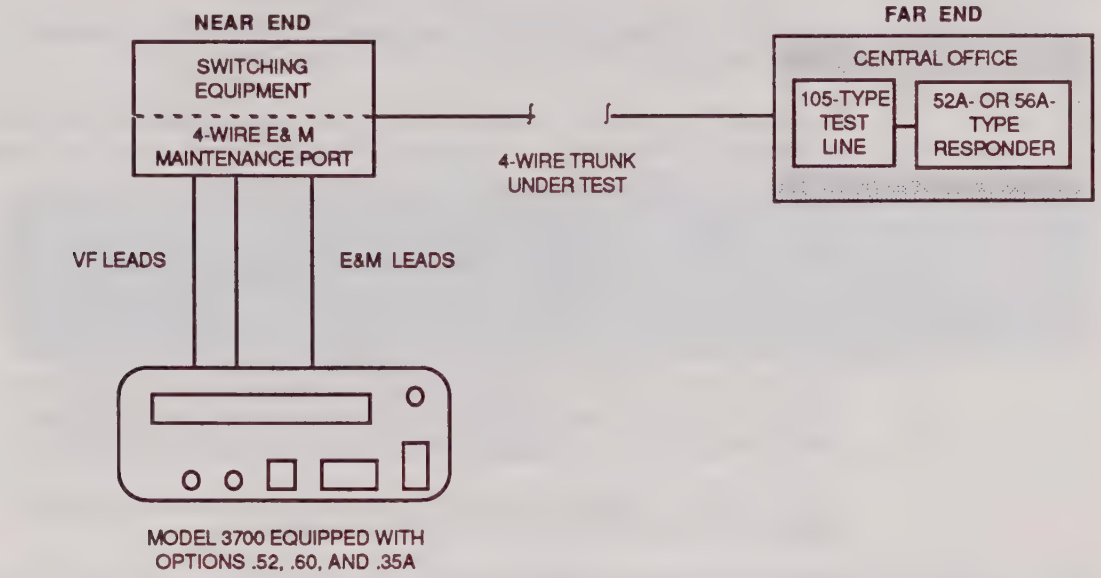
To change measurement mode, return to the SETUP display by pressing the SETUP key in the DISPLAY section of the front panel.

4.9.7 Responder Interface Tests (Option .52)

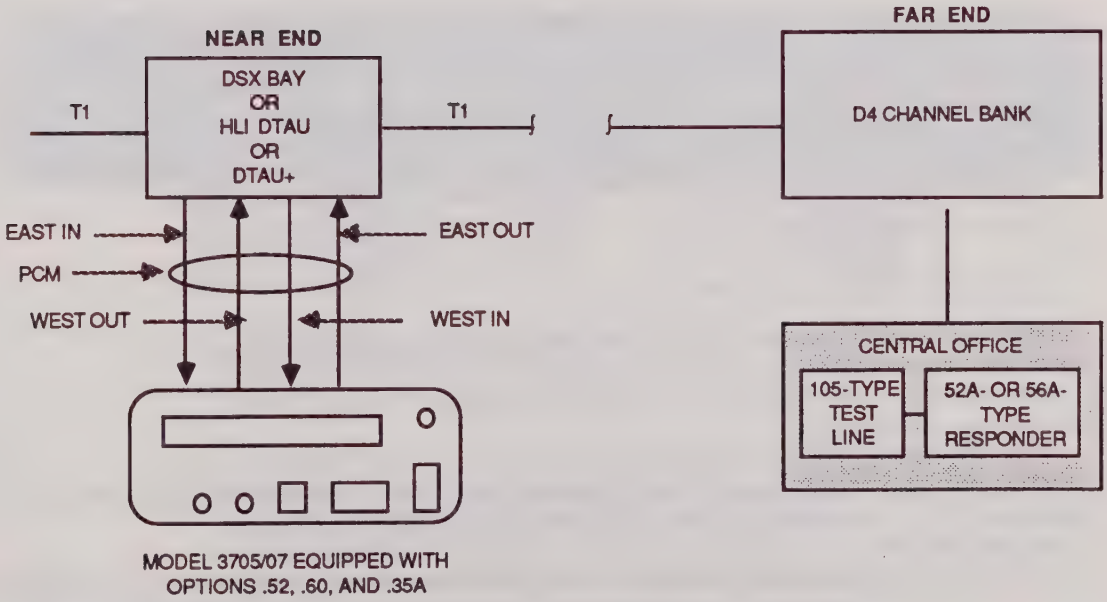
This section describes the operating procedures for Option .52 Responder Interface. Option .52 enables the CTS to function as a near-end responder for two-way testing of 105-type test lines. The option provides two-way measurements of loss, gain slope, C-Message noise, noise-with-tone (C-Notch), echo return loss (ERL), low frequency singing point return loss (SRLLO), and high frequency singing point return loss (SRLHI). Two-way self-checks are also supported. Individual tests are selected and executed using the front-panel soft keys. Test results are displayed following execution of the selected test. The results of previous measurements may be recalled as needed.

Option .52 is fully compatible with 52A- and 56A-type responders, and is designed to meet the requirements of Bellcore Compatibility Bulletin CB 106.

Option .60 DTMF/MF Signaling is required for operating Option .52. Option .60 is a standard feature of all units with Firmware Revision 12 or later. It may also be desirable to have Option .35A or .35C Call Progress and Signaling for remote-control applications.



ANALOG TRUNK TESTING



DIGITAL TRUNK TESTING

780B

Figure 4-77. Responder Interface Test Connections

4.9.7.1 Setup Procedures

Refer to Figure 4-78 and the following paragraphs to set up the CTS for responder interface tests.

TLP Setup: The appropriate transmit and receive TLPs must be set up in order to make accurate tests. The transmit TLP is established by setting the transmit level to the desired transmit TLP. Refer to the signal generator setup instructions in Section 4.6. The receive TLP is set in the Responder Interface Setup Display, Figure 4-78.

Line Interface Setup: For 4W operation, the proper terminations are established in the line display. Refer to Section 4.4. For 2W operation, the termination is established in the setup display, Figure 4-78.

Responder Setup: To activate the responder, press the front-panel key marked LEVEL in the MEASUREMENT section, and then press the first soft key under "resp"; the display changes to "RESP". The responder is now in the setup mode. See Figure 4-78.

4W/2W Selection: Pressing the fourth soft key toggles the unit between 4W and 2W operation.

2W Impedance Selection: If 2W operation is selected, the termination impedance of the line interface may be toggled between 600 ohms, 900 ohms, 1200 ohms, and external by pressing the third soft key.

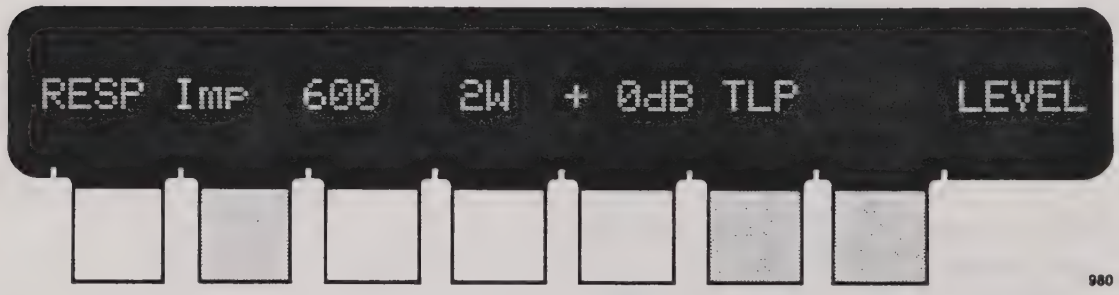


Figure 4-78. Responder Interface Setup Display

4.9.7 2 105-Type Measurements

This section describes the measurement display and operating procedures for Option .52. Refer to Figure 4-79 while performing the following procedures.

Measurement Display: The left half of the measurement display contains the results of the test indicated above the fifth and seventh soft keys. If the indicated test has not yet been performed, or if the test results are invalid, asterisks are displayed in place of the digits. Underrange and overrange test results are identified with minus and plus signs, respectively.

Test results for loss and gain slope are displayed in two parts: far-to-near measurements and near-to-far measurements, followed by the unit of measure if the receive TLP is 0 dB. If the receive TLP is other than 0 dB, the display will show dBrnC0.

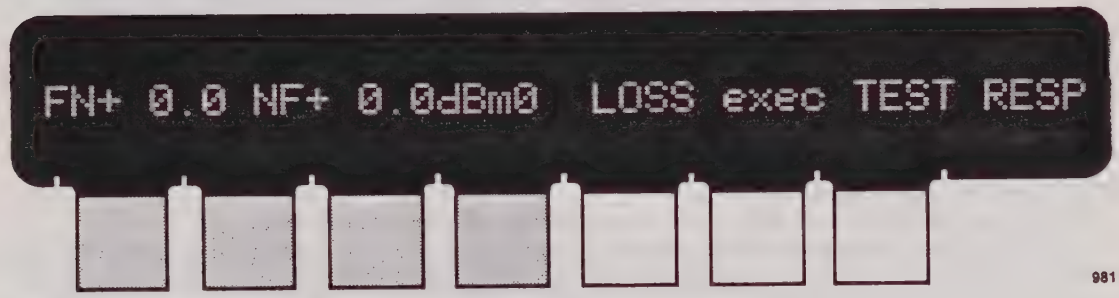


Figure 4-79. Responder Interface Measurement Display

The noise tests, near-end noise (NEN) and far-end noise (FEN) follow the same format as noise-with-tone, except the results for each direction are displayed separately.

Test results for return loss tests are displayed in two parts: near-end return loss, and far-end return loss.

Test Type Selection: The display above the fifth soft key indicates the type of measurement that is to be performed. Pressing the fifth soft key advances the display through each of the tests performed by the responder interface. It specifically measures:

- LOSS (at 1 kHz)
- GS04 (Gain slope at 400 Hz)
- GS10 (Gain slope at 1 kHz)
- GS28 (Gain slope at 2.8 kHz)
- NWT (Noise-with-tone)
- NEN (Near-end noise)
- FEN (Far-end noise)
- SRLO (Low frequency return loss)
- ERL (Echo return loss)
- SRHI (High frequency return loss)
- ALL (Performs all)

Test Execution: Pressing the sixth soft key causes a test or measurement to be performed as indicated by the display over the fifth and seventh soft keys. The display above the sixth soft key changes from "exec" to "EXEC" for the duration of the test.

Test Mode Selection: The display above the seventh soft key indicates the selected measurement mode. Pressing the seventh soft key advances the mode through three possible states (TEST, RLSE, and SCHK). TEST indicates that an actual measurement may be performed by pressing the sixth soft key (exec). SCHK indicates that a self-check measurement may be performed by both the far-end responder and Option .52.

Pressing "exec" when RLSE is displayed causes the far-end test line responder to release the line-under-test (go on-hook).

Performing a Test: Press the LEVEL key in the MEASUREMENT section of the front panel, and activate the responder interface by pressing the first soft key. Press the front-panel switch marked DIAL/TALK, and place a call to the far-end responder. Be sure to press the "-" key on the keypad to terminate the present call. Pressing the "+" key on the keypad initiates a new call. Refer to Section 4.5. After placing a call to the far-end responder, press the level key and then the measure key to return to the responder measurement display. On entry to the measurement display, Option .52 looks for TPT (test progress tone). If TPT is received within three seconds, the message TPT is displayed above the third soft key for as long as TPT is present. When TPT is no longer present, the sixth and seventh soft keys become active, and testing continues as described above.

4.9.8 T1 Bit Error Ratio (Option .65)

This section describes the operating procedures for performing out-of-service PCM bit-error ratio measurements using the Option .65 T1 Bit Error Ratio. The Option .65 is capable of operation at the DS1 rate (1.544 mbps) or at the channelized rate (64 kbps). The Option .65 works in conjunction with the Option .64 ESF PCM Test/Channel Access.

A PCM bit error ration measurement is made by replacing the PCM traffic with a pseudorandom test pattern at one end of the circuit, and then comparing the pattern received to this same pattern and counting the bit errors. If a loopback device such as a CSU or SMJ is installed in the circuit, the test can be performed with a single test set. The Option .65 generates a variety of pseudorandom test patterns, user-defined patterns, all ones, alternating ones and zeros, and 3-in-24 stress pattern, as well as CSU and SMJ loopup and loopdown codes. For the channelized rate, remote data loopback and release codes are generated according to CCITT Recommendation V.54.

The Option .65 also provides a unique frequency difference measurement which shows the difference in frequency between either recovered clock and the internal clock, or between the two recovered clocks. This measurement is useful when troubleshooting clock synchronization problems that may cause slips.

The Option .64 also provides error injection features, and in channelized, a round-trip delay measurement. The round-trip delay measurement is made in conjunction with a far-end loopback at either the primary rate or the channelized rate.

The option .65 pattern generator is connected to the Send direction selected in the PCM Signaling and Control Measurement Display. (See Figures 4-48, and 4-49.) The pattern receiver of the Option .65 is connected to the From direction selected in the same display. The Option .65 is activated by the selection of PTRN 9 Pattern) in the PCM Setup Display 2. (See Figures 4-38, 4-40, 4-41, 4-42, and 4-45.)

4.9.8.1 Bit Error Ratio Setup Procedures

To perform an out-of-service bit error ratio measurement, first set up the parameters of the Option .65 by pressing the PCM key and then the SETUP key until the Bit Error Ratio Setup Display 1 appears as in Figure 4-80.

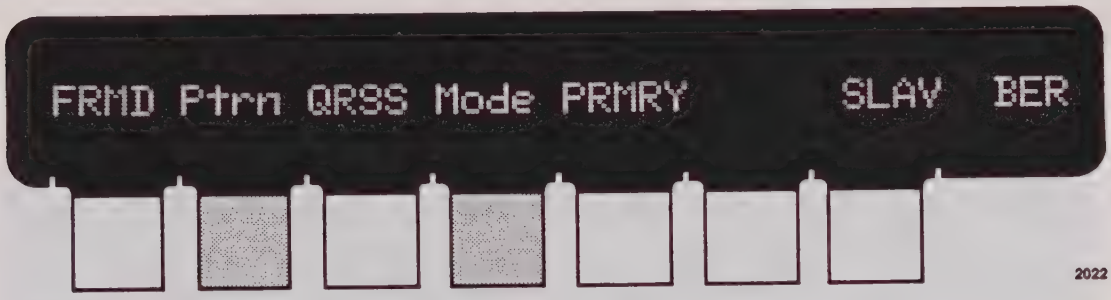


Figure 4-80. Bit Error Ratio Setup Display 1

Framing Selection - The first soft key is used to select framed (FRMD) or unframed (UNFR) output from the Option .65 pattern generator. The type of framing, such as D3/D4 or ESF, is selected in the PCM Setup Display 2. (Refer to Figures 4-38, 4-39, 4-41, 4-42, and 4-45.) The pattern receiver deletes the framing bits when framed output is selected.

Pattern Selection - The third soft key is used to select the type of pattern to be generated and received. The selections include:

- QRSS 2^{20}-1 plus 14 zero suppression
- 511 2^{9}-1 pseudorandom pattern
- 2047 2^{11}-1 pseudorandom pattern
- 2E15 2^{15}-1 pseudorandom pattern
- 2E20 2^{20}-1 pseudorandom pattern
- 2E23 2^{23}-1 pseudorandom pattern
- ALL1 all ones
- ALT alternating ones and zeros (primary only)
- 3/24 3-in-24 stress pattern (primary only)
- USER User-defined (see Section 4.9.8.2)

Mode Selection - The fifth soft key selects the primary (PRMRY) rate of 1.544 mpbs or the channelized (CHNNL) rate of 64 kbps. In primary rate, the whole DS1 is replaced with the selected pattern; in channelized, only one of 24 time slots has the pattern inserted. The channel is selected in the PCM Signaling and Control displays. (See Figures 4-80 through 4-84.) If channelized (CHNNL) is selected, then an additional selection for B8=1 (56 kbps) or clear (CLR) channel (64 kbps) appears over the sixth soft key.

Clock Source Selection - The seventh soft key is used to select the clock source for the send pattern generator. If slave (SLV) is selected, then the send clock source is from the selected receive side, as determined in the PCM Signaling and Control displays. (See Figures 4-48, 4-49, 4-51, and 4-52.) If master (MSTR) clock is selected, then the Option .64 internal crystal clock source is used to run the send pattern generator.

4.9.8.2 Entering a User-Defined Pattern

After selecting user-defined pattern (USER) in the Bit Error Ratio Setup Display 1, press the SETUP key to enter the User-Defined Pattern Setup Display (Figure 4-81).

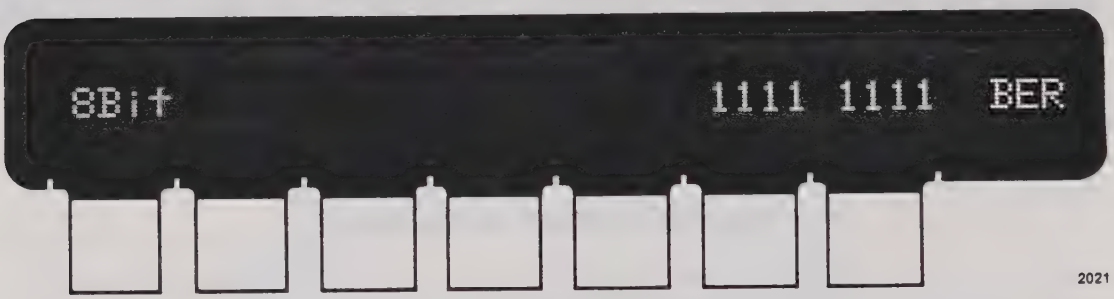


Figure 4-81. User-Defined Pattern Setup Display

Pattern Length Select - The first soft key is used to select the pattern length of 8, 16, or 24 bits.

User-Defined Pattern Entry - For an 8-bit user-defined pattern, soft keys 7 and 8 are used to select the four bits to be entered, then the keypad 1 and 0 keys are used to enter the code. Note that in channelized B8=1, the last bit (B8) always is a 1. For a 16-bit pattern, soft keys 4, 5, 6, and 7 are used; for a 24-bit pattern, soft keys 2, 3, 4, 5, 6, and 7 are used. The pattern is transmitted byte aligned with the framing pattern if framed (FRMD) is selected in the Bit Error Ratio Setup Display 1 (Figure 4-80).

4.9.8.3 Error Injection Setup

It is sometimes useful to purposely inject different error types into the send pattern. For this purpose, use the Bit Error Ratio Setup Display 2 (Figure 4-82).

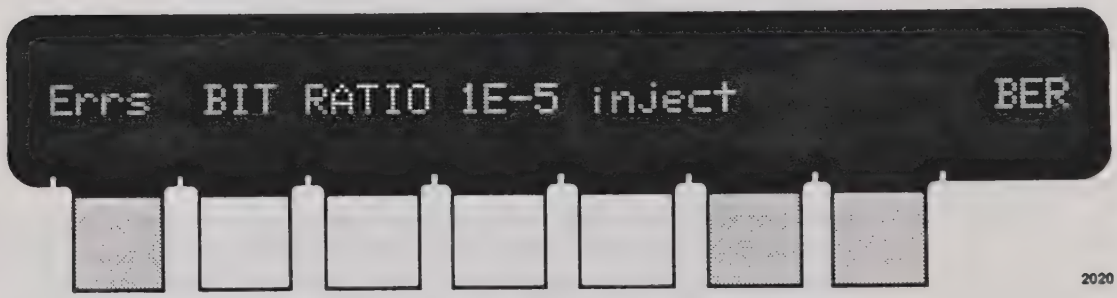


Figure 4-82. Bit Error Ratio Setup Display 2

Error Type Selection - If primary (PRMRY) rate is selected, the second soft key can be used to select the type of error injected:

- BIT bit error (any bit)
- BPV bipolar violation (line code error)
- FBIT framing bit error

If channelized (CHNNL) rate is selected, then only pattern (PTRN) errors may be injected, and the second soft key is disabled.

Error Injection Mode - The third soft key is used to select between a fixed bit error ratio injection and a programmable quantity of errors. If the soft key below RATIO is pressed, QTY will appear.

Error Ratio or Quantity Entry - If RATIO is selected, then pressing the fourth soft key permits the entry of the mantissa and exponent of the error ratio. The mantissa is entered first; it can be 1, 2, or 5. The exponent is entered next; it can be from -3 to -9. The highest ratio possible is 2×10^{-3} and the lowest is 1×10^{-9}.

If QTY is selected, then pressing the fourth soft key permits the entry of the quantity of errors to be injected. The quantity can be from 1 to 99 errors.

Error Injection Control - If RATIO is selected, pressing the fifth soft key toggles error injection on and off. When "INJECT" appears in upper-case letters, error injection is activated. When "inject" appears in lower-case letters, error injection is off.

If QTY is selected, pressing the fifth soft key causes "inject" to change to upper case until the specified quantity of errors is injected, then it returns to lower case. Pressing the fifth soft key again causes the specified quantity of errors to be injected again.

4.9.8.4 Bit Error Ratio Measurement Displays

Once the setup of the Option .65 parameters has been completed, and the appropriate "to" and "from" directions have been selected in the PCM Signaling and Control Display 1, then the Option .65 pattern generator is activated by selecting PTRN in the PCM Setup Display 2. (Refer to Figures 4-38, 4-39, 4-41, 4-42, and 4-45.)

To perform a timed bit error ratio test, press the measurement (MEAS) key until the Bit Error Ratio Measurement Display appears (Figure 4-83). This display is very similar to the PCM Performance Measurement displays (Figures 4-47 and 4-50). In the inline and terminal modes, the selected "from" direction has the Option .65 bit error ratio measurement results appear; in the unselected direction, the standard in-service performance measurement results are displayed. Refer to Section 4.8.2.1.

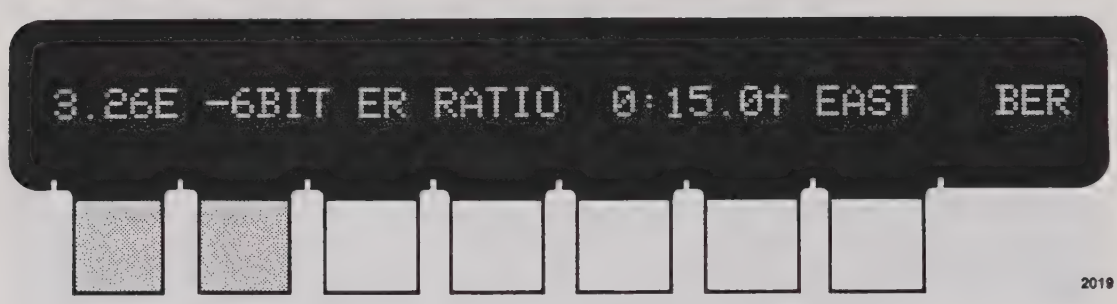


Figure 4-83. Bit Error Ratio Measurement Display 1

Bit Error Ratio and PCM Performance Results - The left-most area of the display shows the results of the bit error ratio measurement and the PCM performance totalizers. The fourth soft key is used to step forward through the results list, and the third soft key is used to step backward. The results are initialized at the beginning of a timed test, and remain available after a test has ended, until a new test is started. Results are listed as follows:

- BIT ER RATIO bit error ratio
- BIT ERROR bit errors
- PTRN SLIP pattern slips
- PTRN SYN LOS pattern synchronization losses
- PTRN LOS SEC pattern synchronization loss seconds
- ASY ERD SEC asynchronous errored seconds
- SYN ERD SEC synchronous errored seconds
- AS SV ER SEC asynchronous severely errored seconds
- SY SV ER SEC synchronous severely errored seconds
- DEGRADED MIN degraded minutes
- UNAVAIL SEC unavailable time (in seconds)
- AS ER FR SEC asynchronous error-free seconds
- SY ER FR SEC synchronous error-free seconds

Timed Test Duration Set - The PCM performance test timer can be set for any duration from 0.1 minutes to 100 hours; it defaults to 15 minutes. To set the timer duration, press the fifth soft key, just to the left of the label t;___:__._ will appear. Enter the most significant through least significant digits of hours, then minutes, and tenths of minutes using the keypad.

Timed Test Start/Stop - The PCM performance test timer is started and stopped by pressing the sixth soft key, directly under the label T. When the label is in lower case, the timer is stopped; when the label is in upper case, the timer is running. When the timer has timed out, the label reverts to lower case, and the accumulated results and test duration are displayed. When a bit error ratio test is in progress, most setup parameter soft keys are disabled until the test is terminated.

Test Result Direction Selection - In the inline or terminal modes, the bit error ratio measurement results are displayed for the selected "from" direction, either east or west. In the unselected direction, the standard PCM performance totalizers are displayed.

(Refer to Section 4.8.2.1.) In the DCS mode, there is only a single DS1, and therefore there is no test result direction selection.

4.9.8.5 Frequency Difference Measurement

If the Option .65 is installed, press the PCM key and then the MEAS key until the Frequency Difference Measurement Display appears (Figure 4-84). This measurement displays the difference in frequency between the two recovered T1 clock signals, EAST In or WEST IN PCM jacks, or between either of the recovered T1 clocks and the internal crystal clock of the Option_64. This measurement is useful when troubleshooting clock synchronization problems which may cause slips.

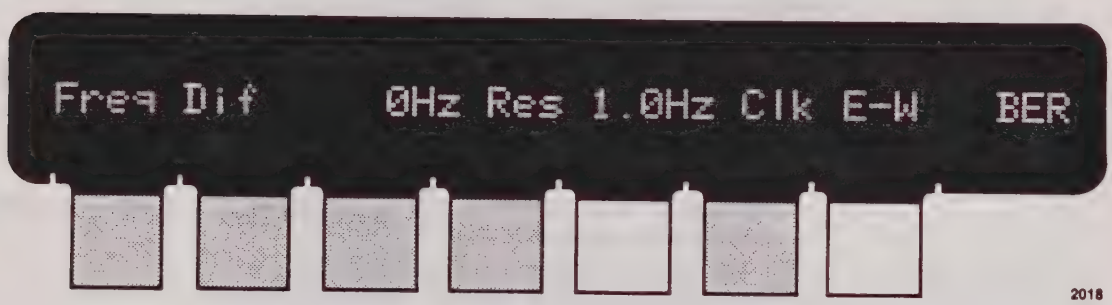


Figure 4-84. Frequency Difference Measurement Display

If a Model 3705/3707 is placed in series with a digital PCM circuit between a DCS (timing source) and a channel bank (loop timed), then the frequency difference between the two recovered clocks must be 0 Hz on the average. If the channel bank is mistakenly set for master timing, a steady frequency difference between the clock signals to and from the channel bank will be measured.

Frequency Difference Display - The left-most area of the display shows the frequency difference measurement result in Hertz. The frequency range is 0 to 9999 Hz or 0 to 999.9 Hz. If one of the signals selected for measurement is absent, then NOPCM will replace the measurement result.

Frequency Difference Measurement Resolution Selection - The frequency difference measurement can be made with a 1 Hz resolution with a 1 second measurement period, or with a 0.1 Hz resolution with a 10 second measurement period. The fifth soft key is used to make this selection.

Clock Source Selection - The seventh soft key is used to select the clock source:

- E-W East IN and West IN clocks
- E-I East IN and internal clocks
- W-I West IN and internal clocks

4.9.8.6 CSU/SMJ/RDL Loopback Display

In order to provide a convenient means of testing toward a remote terminal, Channel Service Units (CSUs) and Smart Jacks (SMJs) provide a loopback capability which aids in sectionalizing a circuit failure. The Option .65 provides a feature to activate and deactivate these loopback devices. In addition, if channelized rate (64 kbps or 56 kbps) has been selected in the Bit Error Ratio Setup Display 1 (Figure 4-80), then Remote Data Loopback (RDL) can be commanded in accordance with CCITT Recommendation V.54. (Note that the circuit must be equipped with a data service unit which conforms to this recommendation.)

For a superframed CSU or SMJ, a repetitive 5-bit code is transmitted for 6 seconds, in place of the traffic, to cause a line loopback. Once a line loopback is established, a 3-bit code is transmitted to release the loopback on a CSU, and a different 5-bit code is transmitted to release the loopback on an SMJ.

For an ESF CSU or SMJ, the facility data link (FDL) is used to transmit the loopback control commands, rather than a fixed code in place of the traffic. There are three sets of loopback FDL commands presently defined:

- Line loopback activate (CSU) 00001110 11111111
- Line loopback deactivate (CSU) 00111000 11111111
- Payload loopback activate (CSU) 00010100 11111111
- Payload loopback deactivate (CSU) 00110010 11111111
- Network loopback activate (SMJ) 00010010 11111111
- Network loopback deactivate (SMJ) 00100100 11111111

The special loopback display is accessed by pressing the PCM key, and then pressing the MEAS key until the CSU/SMJ/RDL Loopback Measurement Display appears. Refer to Figure 4-85.

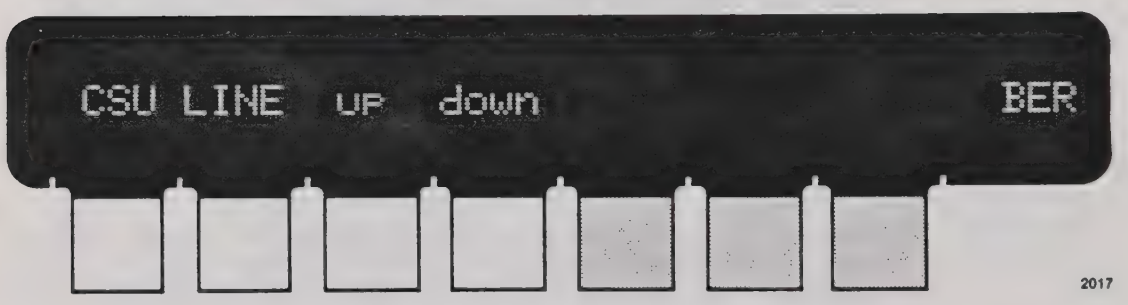


Figure 4-85. CSU/SMJ/RDL Loopback Measurement Display

CSU/SMJ/RDL Selection - The first soft key is used to select the type of device providing the loopback. If primary (PRMRY) rate is selected, CSU or SMJ may be chosen. If channelized (CHNNL) is selected, then only RDL appears.

Loopback Type Selection - If ESF is selected in PCM Setup Display 2 (Figures 4-38, 4-39, 4-41, 4-42, and 4-45), primary (PRMRY) is select in Bit Error Ratio Setup Display 1 (Figure 4-80), and CSU is selected with the first soft key, then the second soft key can be

used to select either a line (LINE) or a payload (PLD) loopback. A line loopback returns every bit unmodified, while a payload loopback strips the old framing and generates new framing while passing the channel data through unchanged.

This selection is not available if channelized (CHNNL) is selected in PCM Setup Display 2, as essentially a payload loopback is available at this point.

Loopback Activation - To command the loopback activation, press the third soft key under "up". The display changes to "UP" and the loopback activation code or message is transmitted for 6 seconds, or until the Option .65 detects that a loopback has occurred. The message CSU LOOPUP, SMJ LOOPUP, or RDL LOOPUP appears at the right-hand side of the display. If the Option .65 detects no loopback, then the right-hand side of the display will remain blank.

Loopback Deactivation - To drop the loopback once activated, press the fourth soft key under "down". The display changes to "Down", and the loopback deactivation code or message is transmitted for 6 seconds. The message CSU LOOPDN, SMJ LOOPDN, or RDL LOOP DN appears at the right-hand side of the display when the Option .65 detects that the send signal differs from the receive signal.

4.9.8.7 Round Trip Delay Measurement Display

To perform a channelized round trip delay measurement, first the channel (64 kbps or 56 kbps) or the entire T1 circuit must have a loopback activated. (Refer to Section 4.9.8.6.) Once the loopback is activated, enter the Round Trip Delay Measurement Display (Figure 4-86) by pressing the PCM key and then the MEAS key until the display appears.

Figure 4-86. Round Trip Delay Measurement Display

Round Trip Delay Measurement Results - In the center of the display area, the round trip delay measurement results appear after proper synchronization of the send and receive signals. When the test is activated, the flag SYNCHRONIZING appears until synchronization occurs, then ****msec appears until the measurement results appear. The measurement range is 0 to 1050 ms; if this range is exceeded, ++++msec appears. If the T1 signal is lost, then NO SYNC-NOPCM appears; if there is difficulty synchronizing, then NO SYNC-PATTERN or NO RESPONSE appears. The measurement resolution is 1 ms.

Round Trip Delay Test Activation - To initiate a round trip delay measurement, press and release the seventh soft key under "test". The display changes to "TEST" and the synchronization process takes place for up to 10 seconds. The test results are displayed for one second, then disappear. If the seventh soft key is held down, then the test will be repeated continuously, about once every two seconds.

4.9.8.8 Sample Out-of-Service Testing

This section provides typical examples of two common testing scenarios: the one-way loopback test and the office-to-office test. The one-way loopback test normally is performed from a central office toward the customer premises.

One-Way Loopback Test - To perform a one-way loopback test, place the Model 3705 in the typical in-line connection as shown in Figure 4-4. (Refer to Section 4.4.2.) The design of the circuit is assumed to be similar to that shown in Figure 4-87.

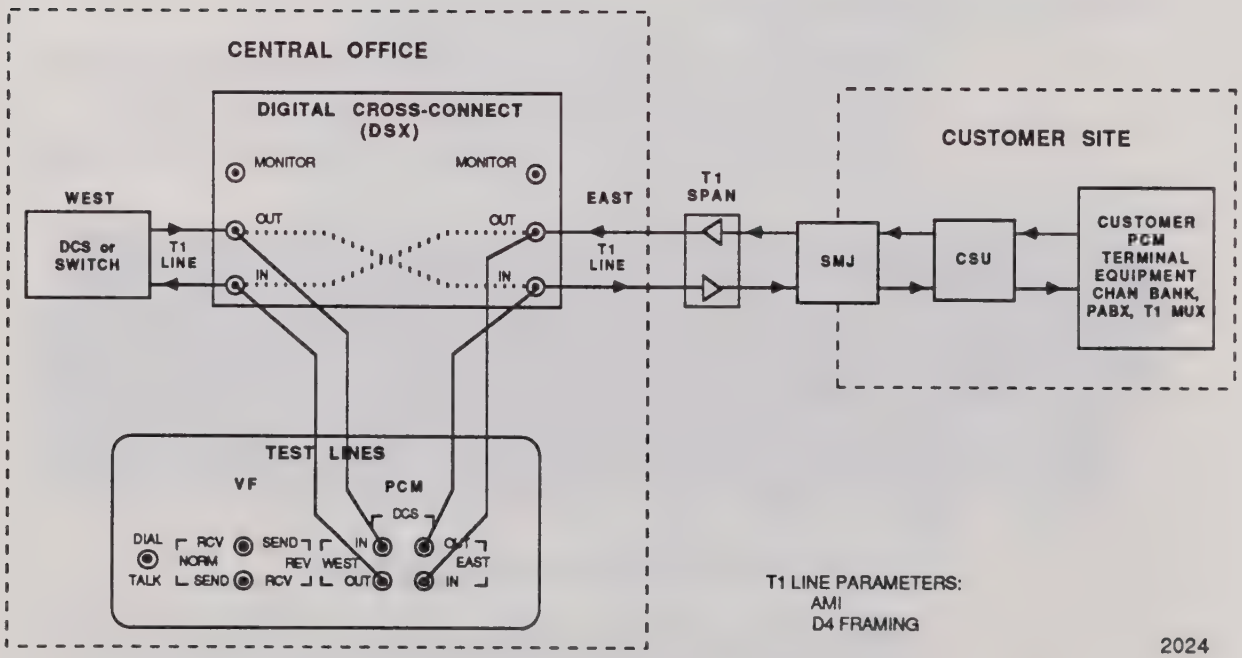


Figure 4-87. Typical One-Way Loopback Test

STEP	PERFORMING ONE-WAY LOOPBACK TEST
1	Press the PCM key, then the second soft key under ON, and select INLIN.
2	Press the SETUP key, and verify that AMI and D3D4 are selected.
3	Press the SETUP key again for the Bit Error Ratio Setup Display 1, and select the pattern to be transmitted. QRSS is the default. Be sure that PRMRY is selected, and select MSTR clock with the seventh soft key.
4	Press the MEAS key until the PCM Signaling and Control Display appears. Select to east ("to e") and from east. Check for the presence of any PCM alarms.
5	Take the line out of service, press the SETUP key until PCM Setup Display 2 appears, and press the sixth soft key under MON until PTRN appears.
6	To set a loopback from the CSU, press the MEAS key until the CSU/SMJ/RDL Measurement Display appears. Select CSU and LINE, then press the soft key under UP. After several seconds, the message CSU LOOPUP should appear, and the circuit is ready for testing.
7	Press the MEAS key again until the Bit Error Ratio Measurement Display appears. Select the EAST direction with the seventh soft key.
8	Enter the test time duration using the fifth soft key. The default is 15 minutes.
9	Start the test by pressing the sixth soft key under "t". If everything is correct, the pattern receiver will synchronize, the test will proceed, and the display will change from "t" to "T".
10	When the test duration set in Step 8 has passed, the timer will stop the test and signal the operator with a long-duration key tone. The results of the test can be observed during or after the test by pressing the third and fourth soft keys to step through the test results.
11	When testing is completed, the circuit must be restored by deactivating the CSU loopback. Press the MEAS key until the CSU/SMJ/RDL Loopback Measurement Display appears. Press the fourth soft key under "down". After several seconds, CSU LOOPDN should appear.
12	To restore the circuit to service, press the SETUP key until PCM Setup Display 2 appears. Press the sixth soft key under PTRN until MON appears. The circuit now is restored to service.

Office-to-Office Test - An office-to-office test is an out-of-service test performed with two Model 3705/3707 Communication Test Sets equipped with Option .65. First set up the Model 3705/3707 test sets as shown in Figure 4-88, then perform the following procedure.

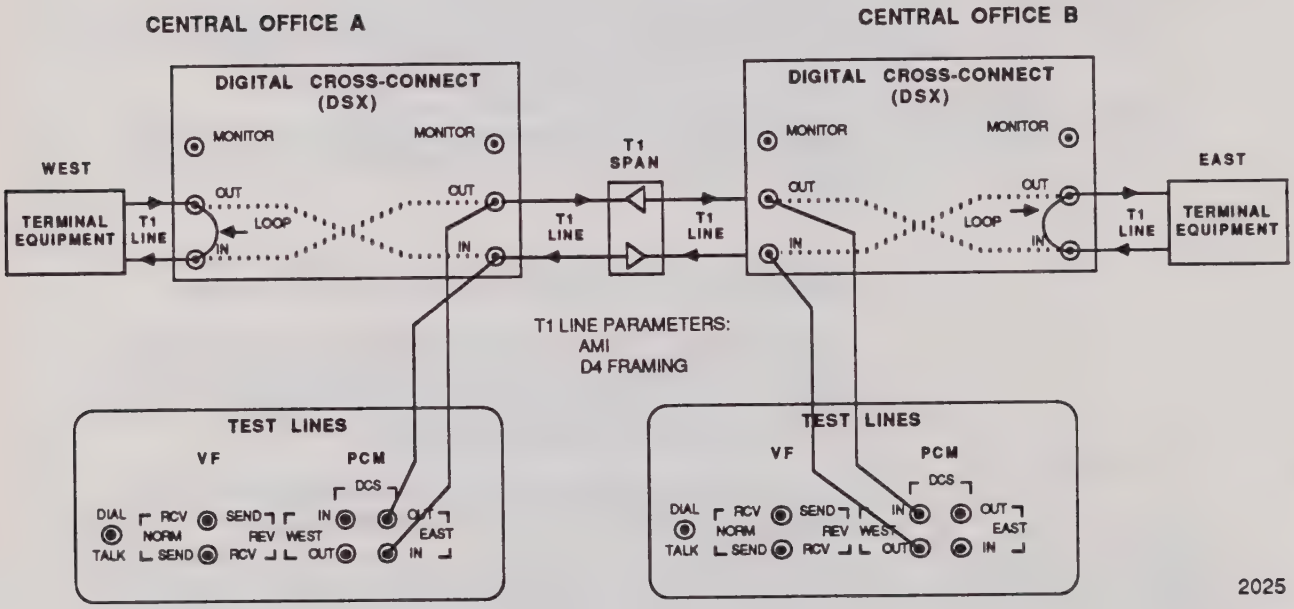


Figure 4-88. Typical Office-to-Office Test

STEP	PERFORMING OFFICE-TO-OFFICE TEST
1	At both offices, press the PCM key, then press the second soft key under ON and the fourth soft key under TRML.
2	At both offices, press the SETUP key, and verify that AMI and D3D4 are selected. Press the fourth soft key and select MSTR clock source.
3	At both offices, press the SETUP key again for Bit Error Ratio Display 1, and select the pattern to be transmitted. QRSS is the default; make sure that PRMRY is selected, and select MSTR clock with the seventh soft key.
4	At central office A, press the MEAS key until the PCM Signaling and Control Display appears. Select to east ("to e") and from east. Check for the presence of PCM from east, and any PCM alarms.
5	At central office B, press the MEAS key until the PCM Signaling and Control Display appears. Select to west ("to w") and from west. Check for the presence of PCM from west, and any PCM alarms.
6	At both offices, activate the pattern generator by pressing the SETUP key until PCM Setup Display 2 appears. Press the sixth soft key until PTRN appears.
7	At central office A, press the MEAS key until the Bit Error Ratio Measurement Display appears, then select EAST with the seventh soft key.
8	At central office B, press the MEAS key until the PCM Performance Measurement Display appears, then press the seventh soft key to select WEST.
9	At both offices, enter the test time duration using the fifth key, unless the default duration (15 minutes) is desired.
10	At both offices, start the test by pressing the sixth soft key under "t". If everything is correct, the pattern receiver will synchronize, the test will begin, and the display will change from "t" to "T".
11	When the test duration set in Step 9 has passed, the timer will stop the test and signal the operator with a long-duration key tone. The results of the test can be observed during or after the test by pressing the third and fourth soft keys to step through the test results.

OPERATION

SECTION 5. REMOTE-CONTROLLED OPERATION

CONTENTS PAGE

5.1 Introduction 5-3
5.2 Setup Requirements 5-3
5.3 Operating Guidelines 5-3
5.3.1 RS-232-C/CCITT V.24 Serial Interface 5-3
5.3.2 IEEE 488 Interface 5-4
5.3.2.1 Talker/Listener Operation 5-4
5.3.2.2 Serial Poll Status Byte 5-4
5.3.2.3 SRQ Function 5-5
5.3.2.4 Additional Interface Functions 5-7
5.4 Master/Slave Operation 5-7
5.4.1 General Information 5-7
5.4.2 Operating Procedures 5-8
5.5 Commands and Output Formats 5-10
5.6 Command Descriptions 5-13
5.6.1 Control Commands 5-14
5.6.2 Line Interface Commands 5-18
5.6.3 Test Signal Generator Commands 5-23
5.6.4 Level, Frequency, S/N Ratio Measurements 5-24
5.6.5 Noise Measurements 5-25
5.6.6 Impulse Noise Measurements (Option .11) 5-26
5.6.7 Hits and Dropouts Measurements (Option .13) 5-27
5.6.8 Envelope Delay Measurements (Option .12) 5-28
5.6.9 Amplitude Jitter Measurements (Option .13) 5-29
5.6.10 Phase Jitter Measurements (Option .13) 5-29
5.6.11 Intermodulation Distortion Measurements (Option .14 or p/o .30) 5-30
5.6.12 P/AR Measurements (Option .18, .18A, or p/o .30) 5-31
5.6.13 Return Loss Measurements (Option .16) 5-32
5.6.14 VOM/CAP Measurements (Option .40) 5-33
5.6.15 ESF PCM Commands (Option .64) 5-34
5.6.16 Responder Interface Measurements (Option .52) 5-37
5.6.17 T1 Bit Error Ratio Measurements (Option .65) 5-38
5.6.18 EasyTest™ Procedure Commands 5-40
5.6.18.1 EasyTest™ Procedure Example 5-41
5.6.18.2 EasyTest™ Procedure List 5-43
5.6.18.3 EasyTest™ Procedure Descriptions 5-43
5.7 Error Messages 5-48
5.8 Remote-Communication Mode 5-48
5.8.1 Remote-Communication Connection 5-49
5.8.2 Remote-Communication Commands 5-50
5.8.3 Remote-Communication Example 5-51

FIGURES **PAGE**

5-1 Sample Controller Sequence 5-6
5-2 Master/Slave Configuration 5-8
5-3 Master/Slave Enable Display 5-9
5-4 EasyTest Procedure SEQ2 Listing and Sample Results 5-42
5-5 Remote Communication In-Line Connection Example 5-49

TABLES **PAGE**

5-1 Serial Poll Status Byte Description 5-5
5-2 Recommended Delay Times 5-9
5-3 Measurement Timing 5-11
5-4 Function and Measurement Definitions 5-12
5-5 Command Information Sources 5-13
5-6 EasyTest™ Procedures List 5-43
5-7 Remote Control Commands 5-51

5.1 Introduction

This section provides instructions for remote-controlled operation of units equipped with Option .25A-232 Remote Control (RS-232-C/CCITT V.24) or Option .25A-488 Remote Control (IEEE 488). Instructions for using the following options are also included in this section:

- Option .41 Master/Slave
- Option .71-001 Basic EasyTest™
- Option .71-002 Master/Slave EasyTest™

Options .25A-232 and .25A-488 provide flexible remote-control capability for the Model 3700-series Communications Test Systems (CTSs). These options allow the CTS to be used in a wide variety of testing applications. The CTS can be used as a simple stand-alone system controlled by a data terminal, or as part of an integrated automated test system such as Hekimian's REACT (Remote Access and Test) 2000 System. These remote-control options contain a comprehensive software package that provides a set of commands to control the test set configuration and return measurement results through an EIA RS-232-C/CCITT V.24 serial interface or an IEEE 488 interface. These options are plug-in boards that plug into a dedicated slot in the CTS basic unit. Interface connectors and configuration switches for these options are located on the rear panel of the unit.

5.2 Setup Requirements

Prior to remote-controlled operation, the CTS must be set up as described in Section 3. Refer to Section 3 for applicable setup procedures.

5.3 Operating Guidelines

This section provides guidelines for operating a unit with an RS-232-C/CCITT V.24 or IEEE 488 interface. These guidelines should be reviewed prior to operating the CTS.

5.3.1 RS-232-C/CCITT V.24 Serial Interface

Command entry begins when the Option .25A-232 sends a prompt (->), indicating it is ready to receive a command. The option echoes each character as it is received to ensure correct command transmission and reception. The execution of the command is initiated by a carriage return (CR ASCII 0D). The option echoes the carriage return and then proceeds to execute the command. The option does not insert added delays on carriage return. When a command has been completed and the output data, if any, has been transmitted, a new prompt is sent.

If an error is made while entering a command and a carriage return has not been sent, a rubout or delete character (ASCII 7F) may be used to delete a character from the input buffer. The deleted character is echoed for clarity in place of the rubout character. A backspace (ASCII 08 or CTRL-H) may be used to perform the same function, but the deleted character is not echoed.

If it is desired to scrub the contents of the input buffer, sending a CTRL-D (ASCII 04) causes a new prompt. Characters transmitted to the option that is collecting data are ignored (and not echoed) except for CTRL-A (ASCII 01), which scrubs the measurement in progress and returns a prompt.

5.3.2 IEEE 488 Interface

This section provides general information on command entry with IEEE 488 interface-equipped units. The following topics are covered:

- Talker/Listener Operation
- Serial Poll Status Byte
- SRQ Function
- Additional Interface Functions

Refer to the following paragraphs for information on these topics.

5.3.2.1 Talker/Listener Operation

When the CTS with Option .25A-488 powers up, it is in the LOCAL state, and the unit may be operated from the front panel. The unit enters the REMOTE state when My Listen Address (MLA) is received with REN true. The parameters set into the unit are retained when going into REMOTE. The unit is now ready to receive commands in ASCII format. The input string must be terminated by EOI on the last character, a carriage return (ASCII 0D), or a line feed (ASCII 0A) as selected on the internal DIP switch. When set to the talker mode, the Option .25A-488 returns ASCII data followed by either a carriage return with EOI or a carriage return followed by line feed with EOI, as selected on the internal DIP switch.

5.3.2.2 Serial Poll Status Byte

Upon receipt of Serial Poll Enable (SPE) and My Talk Address (MTA), the Option .25A-488 transmits a status byte. Refer to Table 5-1 for the serial poll status byte bit assignments. If the status byte is 00 hex, then the Option .25A-488 is idle and, therefore, ready to receive a command.

It is important to detect whether the Option .25A-488 is busy. When in a busy condition, a previously-entered command is being processed, and any command or data transmitted to the Option .25A-488 is ignored, although handshakes are completed. A status byte of 02, 03, 42 or 43 hex tells the controller that the Option .25A-488 has data to be transmitted, and any command or data transmitted to the Option .25A-488 is ignored.

TABLE 5-1. SERIAL POLL STATUS BYTE DESCRIPTION

BIT	DESCRIPTION
1	Busy
2	Data available
3	Not used
4	Not used
5	Not used
6	SRQ
7	Not used
8	Not used

5.3.2.3 SRQ Function

The SRQ function may be used to signal the controller that the Option .25A-488 has data to be collected. A segment of the rear panel DIP switch is used to enable the SRQ function. With the SRQ function enabled, the serial poll status byte is 42 or 43 hex when data is ready to be sent to the controller. With SRQ not enabled, the serial poll status byte is 02 or 03 hex when data is ready. Once SRQ is activated, it is released if one of the following bus actions occur:

1) A serial poll of the Option .25A-488 is conducted.

2) A Device Clear (DCL) or Selective Device Clear (SDL) occurs.

3) REN is dropped and the unit returns to the LOCAL state.

4) Option .25A-488 is in the talker mode and all bytes to be transmitted have been sent.

Once all bytes of data are transmitted and SRQ is released, the status byte returns to 01 hex if it is still processing a command, or 00 hex if it is now idle. Figure 5-1 shows a typical controller sequence for sending and retrieving data from an Option .25A-488.

The Option .25A-488 also supports the parallel poll function. Parallel poll provides a faster response time to SRQ than is possible using serial polls. The Option .25A-488 can be configured by the controller to give its data-available response on any of the eight data bus wires; thus, seven other devices may also be polled simultaneously to determine who needs service.

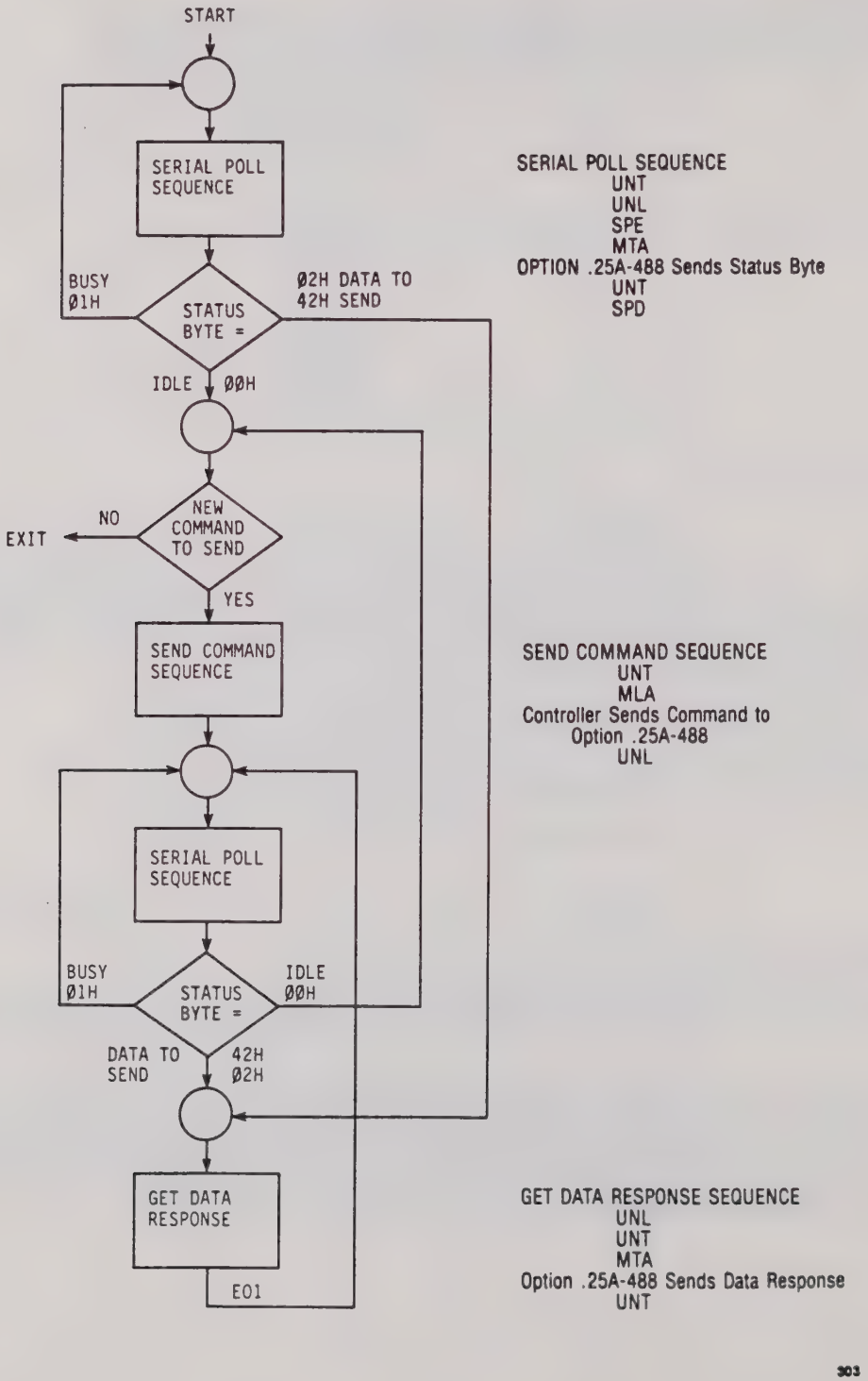


Figure 5-1. Sample Controller Sequence

5.3.2.4 Additional Interface Functions

The Option .25A-488 responds to several other useful IEEE 488 interface functions. The universal interface command Device Clear (DCL) or the addressed command Selective Device Clear (SDC) causes the CTS and Option .25A-488 to perform a hardware reset in the same manner as an SCLR command. The unit returns to the LOCAL state with the generator in quiet termination, and terminates any measurement which may have been in progress.

The universal command Interface Clear (IFC) is equivalent to clearing SRQ and performing the sequence UNT, UNL, SPD. Whatever had been occurring inside the Option .25A-488 is not interrupted and, by appropriately assigning the unit to talker or listener, it allows data transfers to continue.

The addressed command, Go To Local (GTL), or the release of REN to false causes the Option .25A-488 to go to the LOCAL state. The unit then responds to the front panel controls.

NOTE: In going to the LOCAL state, the following are disabled if active: internal loopback, high pass filter, jitter test source, signal-to-noise test, IMD test, P/AR test, loopback tone, remote communication (PCM), SF hold outside of DIAL/TALK, or support of FX sequences.

5.4 Master/Slave Operation

This section contains instructions for master/slave operation. In master/slave operation, a "master" test set at one end of the line under test is used to control a "slave" test set at the other end of the line. Master/slave operation of the CTS requires Option .41 Master/Slave and Option .25A-232 Remote Control (RS-232-C/CCITT V.24).

5.4.1 General Information

Option .41 Master/Slave provides the capability to control a distant-end test set using only the 4W (4-wire) lines under test. The option is used with Option .25A-232 Remote Control (RS-232-C/CCITT V.24). Option .41 is a PC board which plugs into a short option slot in the CTS. Functionally, the option is a special-purpose, 300-bps FSK (Frequency Shift Keying) modem designed to distinguish between test signals and qualified modem signals. This is accomplished with a 103A-type modem sending and receiving on the original frequencies, and a 2.1-kHz pilot tone. The receive side includes level and frequency discrimination to recognize the modem and pilot signals. The modem is used to control the slave end and to send data back to the master end. The master/slave configuration is shown in Figure 5-2.

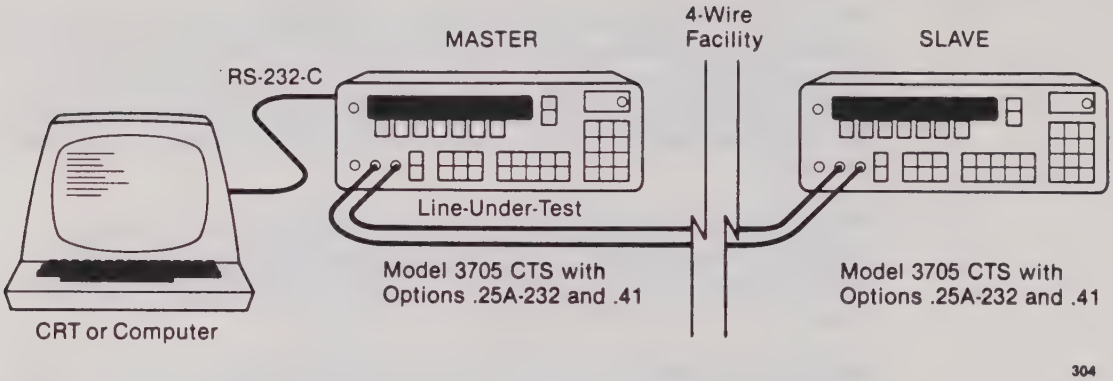


Figure 5-2. Master/Slave Configuration

5.4.2 Operating Procedures

To use the master/slave capability, install the CTSs and CRT according to Figure 5-2. Apply power to the instruments and CRT terminal. The CRT may now be used to control the master unit using the commands described in Table 5-7. To communicate with the slave unit, type <ESC>S<CR>. A new prompt appears, and subsequent commands are executed by the slave unit.

The transmission path control character may be changed from <ESC> (ASCII 1B) to any control character (ASCII 00 to 1F except 01, 02, 03, 04, 08, 0D, 11, and 13). This change may be needed in systems where <ESC> already has a defined function. The character is changed by the SESC command. An ASCII printing notation is used to define the control character. The characters ↑ (ASCII E5) to indicate CTRL, followed by @ (ASCII 40) through ← (ASCII 5F), are used to map the ASCII 00 to 1F nonprinting characters. For example, if the desired path control character is BEL (ASCII 07), the command would be SESC ↑G. The default character at power-up is <ESC> and is shown as ↑[using the DESC command.

When making measurements at the slave end, the SDEL command must be used to delay the measurement until the modem signals are dropped, the test signals are restored to the input of the slave, and the measurement settles. The amount of delay required varies greatly in each measurement. For example, level is relatively fast, and more than several seconds of delay would be unnecessary. However, measurements such as envelope delay, P/AR (Peak-To-Average Ratio), or IMD (Intermodulation Distortion) may require significantly longer times to ensure fully settled readings. Table 5-2 contains a list of suggested delay times.

TABLE 5-2. RECOMMENDED DELAY TIMES

MEASUREMENT	NORMAL (sec)	DAMPED (sec)
Level/Freq.	2	4
Level/Freq./SN	4	--
Noise	3	10
Impulse Noise	2	--
Hit/DO	2	--
Env. Delay	5	7
Ampl. Jitter	5	--
Phase Jitter	5	--
IMD	10	--
P/AR	6	12
4W Ret. Loss	4	18

The send level for the Option .41 is independently set using the SMSL command from the normal generator send level set with the SSND command. This feature allows quiet termination and variable test signal levels while ensuring reliable modem operation. The default value for the master/slave send level is -16 dBm.

NOTE: The actual send level is 3 dB rms (root-mean-square) above this level due to the addition of the modem and pilot tones.

The SMSL command also has an OFF parameter which may be used to disable the master/slave capability during remote operation. This parameter is cleared on SCLR power-up, when using an <ESC>S sequence, or when using SMSL without the OFF parameter. During manual front-panel operation, the master/slave capability may be disabled by pressing the LINE key, followed by the "4" key on the keypad. Press the fourth soft key located below ON as shown in Figure 5-3. After pressing the soft key, OFF replaces ON in the display indicating that master/slave operation is disabled.

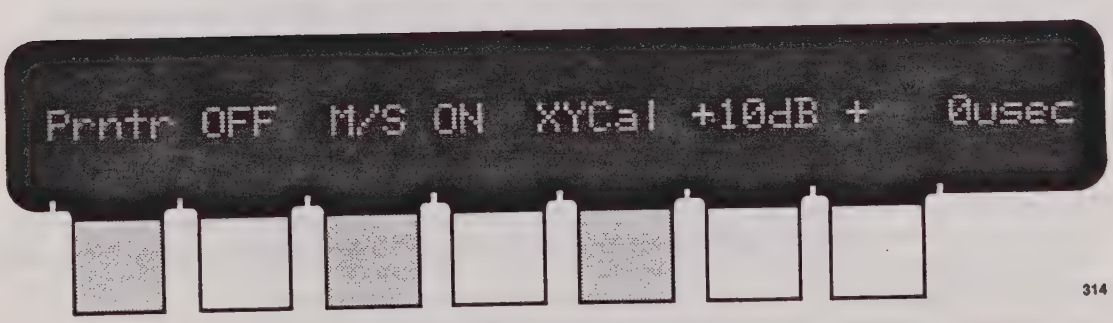


Figure 5-3. Master/Slave Enable Display

To re-enable the master/slave capability, press the fourth soft key located below OFF. ON then replaces OFF in the display. The master/slave capability can also be enabled by turning the unit off, then on again.

The Option .41 at the master end can be self-tested by typing <ESC>S<CR> with the unit in internal loopback. The modem now echoes characters from the CRT terminal through the Option .25A-232, to the Option .41 transmitter and the send side of the CTS. The modem signal is then looped back to the receive side and the Option .41 receiver, to the Option .25A-232, and to the CRT terminal.

CAUTION: If executed by the slave unit, the following actions stop any further communication with the unit:

- **Setting REV in SLIN, SDPS, SDTT, SDMF, SVMC, DIAL**
- **Setting LOOP in SLIN**
- **Setting 2W6, 2W9, 2W12, or 2W EXT in SRLS**
- **Setting NTG in SNSE or SSLV**
- **Activating PCM if on a VF channel or disabling PCM if on a PCM channel**

When the CTS is being controlled in the slave mode, commands from the local port result in the error message E10 SLV MODE. Local control may override the slave mode (interrupting the master/slave test) by sending a CTRL-A. A new prompt appears and the unit responds to commands from the local port. To release a slave unit from the slave mode, the command SEXS is sent from the master to the slave set.

5.5 Commands and Output Formats

The commands of the Option .25A-232 and .25A-488 are composed of a three-to-five character alphabetical command followed by a parameter field of up to 76 characters. The first alphabetical character is a prefix used to define the function of the command as follows:

- S-prefixed commands set parameters and/or a measurement type
- D-prefixed commands display parameter status
- M-prefixed commands start a measurement sequence

A measure command need not be preceded by a set command, but if measurement parameters must be changed, then a set command is required. Note that the delay at the entry of a measure command may not be adequate to ensure a stabilized reading; for example, a Bell standard plus low frequency jitter measurement may require up to 30 seconds to stabilize. In this case, the operator must insert delays and verify that the reading is stable. There is no delay on retrieving data on subsequent measurement commands of the same type. The delay at entry of the measure command occurs only when entering a new measurement, or when a parameter of the measurement has been changed with a set command. Refer to Table 5-3 for measurement timing information.

TABLE 5-3. MEASUREMENT TIMING

MEASUREMENT	MEAS TIME (sec)	UPDATE (msec)
Level/Freq.	3.0	500
Level/Freq./SN	6.0	700
Noise	4.5	350
Impulse Noise	3.0	--
Hit/Dropouts	3.0	--
Ampl. Jitter	5.5	500
Phase Jitter	5.5	500
IMD	8.5	2500
P/AR	4.0	1000
Return Loss	5.0	300
VOM/CAP: V & MA	5.0	700
RESL	5.0	1600
RESH	5.0	3700
CAPL	5.0	1700
CAPH	5.0	3200
Clear (SCLR)	8.0	--
(SCLR W)	1.0	--

The next three alphabetical characters describe the function and measurement definitions. These definitions appear in Table 5-4.

Following the three-to-five character command is the parameter field, which is used to enter numeric parameters and set measurement conditions. These parameters must be separated from the command and other parameter fields by a comma (ASCII 2C) and/or any number of spaces (ASCII 20).

Many parameters can be abbreviated. For example, the parameter HOLD can be entered as H and the parameter 600 can be entered as 6. These parameters are indicated on the second line under the command format.

Some parameters are momentary and automatically become false if an S command is executed without including the momentary parameter label. All other parameters remain the same if they are omitted from an S command; thus, only the parameters which are to be changed must be entered. For example, if an SLIN HOLD command is followed by an SLIN command, the HOLD function activates and automatically toggles off at the execution of the second command. Unless otherwise specified, the numerical parameter entries have the same range as in front panel-controlled operation.

The measurement commands normally consist of four alphabetical characters, except for special functions where input parameters are required for timed test. As an example, "MIHD" (Impulse Noise, Hits, and Dropouts) requires a measurement time and print-interval time selection before the test can be performed. If these parameters are omitted, the returned display is the contents of the storage register, which may be zeroes or the results of the last measurement.

TABLE 5-4. FUNCTION AND MEASUREMENT DEFINITIONS

COMMAND	FUNCTION/MEAS	COMMAND	FUNCTION/MEAS
ADN	Automatic Dial Number	IMD*	Intermod. Distortion
AMJ*	Amplitude Jitter	IMP	Impulse Noise
BER*	Bit Error Ratio	LIN	Line Interface
BUF	Output Buffering	LPS*	Loop-Start Signaling
CAP	Capability	LVL	Level-Freq.-S/N Ratio
CLR	Initialization	MFL	DTMF & MF Send Level
CPG*	Call Progress	MSL*,**	Master/Slave Send Level
DEL*,**	Slave Measurement	NON	No Signaling
DLY*	Envelope Delay	NSE	Noise
DMF	Dial (MF Signaling)	PAR*	P/AR
DPS	Dial (Pulse Signaling)	PCM*	PCM
DTT	Dial (DTMF Signaling)	PCS*	PCM Signaling
EIA	Serial Interface Param.	PHJ*	Phase Jitter
EMS*	E&M Signaling	RLS	Return Loss
ESC*,**	Path Control Character	RSP*	Responder Interface
EXS**	Exit Slave Mode	RTT*	Receive Address Digits
FLV	Fast Level/Frequency	SFS*	SF Signaling
GDY*	Group Delay	SND	Send Side
GSS*	Ground-Start Signaling	SUP*	Supervision
GTL	Go-to-Local	SWP	Sweep
HDO*	Hits and Dropout	TIM	Real Time Clock
IHD*	Impls. Noise, Hits, DO	VMC*	Volt/Ohm/Capacitance

*Requires options to be installed in the CTS
**Option .25A-232 only; not functional in Option .25A-488

The data output formats for the Option .25A-232 are always preceded by at least two space characters. Also, each data parameter is separated from the next by two or more space characters. Overrange is indicated by all numeric digits being replaced by plus (+) characters, and underrange by minus (-) characters. Whenever the reading is out of range completely, the numeric digits are replaced by asterisks (*). The maximum line length is 80 characters.

The Option .25A-488 data output formats are the same as the Option .25A-232, with the following exceptions:

1) There are no spaces preceding a data output.

2) Where more than one line makes up a response, the data output formats are separated by a semicolon (;) and not a carriage return or line feed.

3) The maximum length string without a semicolon is less than 255 characters.

5.6 Command Descriptions

In remote-control operation of the CTS, a data terminal performs the functions of the CTS front-panel controls and display. Essentially, the terminal keyboard replaces front-panel controls, and the display on the terminal replaces the front-panel display. Therefore, much of the information in Section 4 is also relevant to remote-control operation. Table 5-5 provides a cross-reference between related information in Section 5 and Section 4.

TABLE 5-5. COMMAND INFORMATION SOURCES

COMMAND FUNCTIONS	SECTION 5	SECTION 4
Display Software and Revision Level	Paragraph 5.6.1	Paragraph 4.2
Calendar Clock Control	Paragraph 5.6.1	Paragraph 4.2
RAM Buffer	Paragraph 5.6.1	Paragraph 4.2
Line Interface	Paragraph 5.6.2	Paragraph 4.4
Supervision	Paragraph 5.6.2	Paragraph 4.5.3
Call Progress Detection (Option .35A or .35C)	Paragraph 5.6.2	Paragraph 4.5.6
Dialing/Display Received Digits	Paragraph 5.6.2	Paragraph 4.5
Test Signal Generator	Paragraph 5.6.3	Paragraph 4.6
Level, Frequency, S/N Ratio Measurements	Paragraph 5.6.4	Paragraph 4.7.1
Noise Measurements	Paragraph 5.6.5	Paragraph 4.7.2
Impulse Noise Measurements	Paragraph 5.6.6	Paragraph 4.9.1
Hits and Dropouts Measurements	Paragraph 5.6.7	Paragraph 4.9.1
Group Delay Measurements	Paragraph 5.6.8	Paragraph 4.9.2
Amplitude Jitter Measurements	Paragraph 5.6.9	Paragraph 4.9.3
Phase Jitter Measurements	Paragraph 5.6.10	Paragraph 4.9.3
Intermodulation Distortion Measurements	Paragraph 5.6.11	Paragraph 4.9.4
P/AR Measurements	Paragraph 5.6.12	Paragraph 4.9.5
Return Loss Measurements	Paragraph 5.6.13	Paragraph 4.9.2
VOM/CAP Measurements	Paragraph 5.6.14	Paragraph 4.9.6
ESF PCM Measurements	Paragraph 5.6.15	Paragraph 4.8
Responder Interface	Paragraph 5.6.16	Paragraph 4.9.7
Bit Error Ratio Measurements	Paragraph 5.6.17	Paragraph 4.9.8

NOTE: During remote-control operation, a list of commands can be displayed by executing the HELP command. The HELP command can also be used to display a list of parameters for any command.

5.6.1 Control Commands

Control commands are used at various times during remote-controlled operation. Therefore, you should familiarize yourself with these commands before using the CTS in remote control. The following paragraphs describe these commands in detail.

CONTROL COMMANDS

Initialization Command: SCLR

```
WARM22
W
(basic unit warm start, if no W or WARM
parameter,a hardware reset is performed))
```

Go-to-Local Command: SGTL

Input Control Commands:*

Backspace	RUBOUT (ASCII 7F), CTRL-H (ASCII 08)
Scrub Line	CTRL-D (ASCII 04)
Stop Measurement in Progress	CTRL-A (ASCII 01)
Restore Local Control from Slave Mode	CTRL-A (ASCII 01)
Stop PROC in Progress	CTRL-A (ASCII 01)
Stop Transmission (X off)	CTRL-S (ASCII 13)
Resume Transmission (X on)	Any character but CTRL-S (ASCII 13)
Resume Transmission (X on)	CTRL-Q (ASCII 11)

Display CTS Configuration Commands:

```
Display Model, Firmware Release, Capabilities:  DCAP

COPYRIGHT 19XX HLI ALL RIGHTS RESERVED
HLI 370X  REV XYY.YY
.07       X-Y OUTPUTS
.08       4Z I/O
.09       20KHZ OPERATION
.10       120KHZ OPERATION
.11       IMPULSE NOISE
.12       ENV DELAY (for.12 or .12A)
.13       HITS/JITTER
.14       INTERMOD DIST
.15       NOISE FILTERS
.15B      NOISE FILTERS
.15C      NOISE FILTERS
```

CONTROL COMMANDS (continued)

```
.16         RETURN LOSS
.18         P/AR (for .18 or .18A)
.25A-232    REMOTE CONTROL RS232  REV XYY.YY
.25A-488    REMOTE CONTROL IEEE 488  REV XYY.YY
.30         IMD & P/AR
.35A        CALL PROGRESS
.35C        CALL PROGRESS
.40         VOM/CAP
.41         MASTER/SLAVE
.52         RESPONDER INTERFACE
.60         DTMF/MF
.62         PCM
.64         ESF PCM
.65         T1 BER REV XYY.YY
.70         EASYTEST INTERPRETER
.71-001     BASIC EASYTEST REV XYY.YY
.72         EASYTEST EDITOR
.74         RAM BUFFER
```

Display Serial Interface Transmission Parameters Command: DEIA

```
7 DATA      1 STOP      NOPARITY          110
8 DATA      2 STOP      PARITY ODD        thru
                        PARITY EVEN       9600
```

Display Installed EasyTest™ Procedure Set Command:

```
DIR A  or  DIR R  or  DIR H  or  DIR
(all)      (RAM)     (hidden)   (major)
```

```
DIRECTORY OF .71-001 M/S EASYTEST REV A10.03

PROC       SIZE       STATUS
LLFSWP      183        ROM
            thru
DMAST       155        ROM
12129 RAM BYTES FREE
```

Help Commands:

Display list of commands: HELP

Display list of command parameters: HELP <command>

CONTROL COMMANDS (continued)

Master/Slave and Transmission Path Control Commands (Option .41)*

Send following commands to Master CTS: <ESC(ASCII 1B)>M<CR>

Send following commands to Slave CTS: <ESC(ASCII 1B)>S<CR>

Set transmission path control character:

SESC ΛX
(where Λ indicates CTRL and X is ASCII values 40 through 5F except 41-44, 48, 4D, 53)

Display transmission path control character: DESC

ΛX
Λ[2

Slave Measurement Delay Setup:

SDEL XXSEC
0SEC2
(delay duration where 0≤XX≤99)

Master/Slave Send Level Setup:

SMSL ±XX.XDBM OFF1
-16.0DBM2
(send level +10.0≥XX.X≥-70.0) (Disable M/S)

Display Master/Slave Send Level Setup: DMSL

±XX.XDBM OFF

Exit Slave Mode: SEXS

Send commands which follow to Master, but continue to pass Slave data:

<ESC(ASCII 1B)>R<CR>
(For use in EasyTest™ procedure. Cleared by <ESC>S or <ESC>M.)

CONTROL COMMANDS (continued)

Calendar/Clock Commands:

Calendar Clock Setup:

```
STIM  MM/DD/YY  hh:mm:ss
where 01≤MM≤12  month
      01≤DD≤31  day
      00≤YY≤99  year
      00≤hh≤23  hour
      00≤mm≤59  minute
      00≤ss≤59  second
```

Display Time: DTIM

MM/DD/YY hh:mm:ss

RAM Buffer Commands (Option .74):

Enable RAM buffering:	SBUF ON
Disable RAM buffering:	SBUF OFF DUMP
Disable RAM buffering and print stored data:	SBUFF OFF DUMP
Print stored data (RAM buffer must be disabled):	SBUF DUMP

5.6.2. Line Interface Commands

LINE INTERFACE COMMANDS

Line Interface Setup Command:

```
SLIN  135 or 600 or 900 or 1200
       1      6      9      12
      (send and receive impedance)

      135SND or 600SND[2] or 900SND or 1200SND
       1SND       6SND       9SND       12SND
      (send impedance)

      135RCV or 600RCV[2] or 900RCV or 1200RCV
       1RCV       6RCV       9RCV       12RCV
      (receive impedance)

      BRDG[2] or TERM,     NORM[2] or REV,     HOLD[1,19]     LOOP[1,5]
        B         T          N        R          H             L
        (rcv term)       (line reversal)     (hold)       (loopback)
```

Display Line Interface Setup Command: DLIN

```
      135SND or 600SND or 900SND or 1200SND
      135RCV or 600RCV or 900RCV or 1200RCV
      BRDG or TERM    NORM or REV    HOLD    LOOP
```

Supervision Selection Command:

```
Loop-Start Supervision Signaling (w/o Option .35A or .35C)

SLPS[2]
Display Supervision Status:  DSUP
LOOP-START

Loop-Start Supervision Signaling (w/Option .35A or .35C)

SLPS[2]   BATTFEED[1]  or  RBWD[1]
      (internal battery)

Display Supervision Status:  DSUP
LOOP-START    IDLE or BUSY or RING    BATTFEED    BNORM or BREV
Wink Detect Response:
SHORT WINK or WINK or OFFHOOK or NO DETECT
Ground-Start Supervision Signaling (w/Option .35A or .35C)

SGSS   BATTFEED[1]  or  RINGGND[1]
(internal battery)  (ground ring terminal)
```

LINE INTERFACE COMMANDS (continued)

```
Display Supervision Status:  DSUP
GND-START    IDLE or BUSY or RING     BATTFEED or RINGGND
Tip Ground Detection:          DSUP TIP[1]
GND or OPEN    BATTFEED    RINGGND

E&M Signaling (with Option .35A or .35C)

SEMS THRU[2] or SPLT,      LINE REL[2]      EQPT REL[2]          1
                              SEZ               SEZ             2
                              SEZWD             SEZWD           3
                                                                4
                                                                5
(monitor control) (split mode line/eqpt supervision)  (type)

Wink Detect Response:
SHORT WINK or WINK or OFFHOOK or NO DETECT

Display Supervision Status:  DSUP
E&M  LINE  IDLE or BUSY  EQPT  IDLE or BUSY
THRU or SPLIT   LINE  REL  EQPT  REL   TYPE 1
                      SEZ        SEZ   TYPE 2
                                       TYPE 3
                                       TYPE 4
                                       TYPE 5

SF Signaling (w/Option .35C)

SSFS ON[2] or OFF or OFFWD,       H
(SF supervision)          (hold SF state outside DIAL/TALK)

Display Supervision Status:  DSUP
SF PRESENT or ABSENT    ON or OFF

Wink Detect Response:
SHORT WINK or WINK or OFFHOOK or NO DETECT

No Signaling (4W circuit)

SNON
Display Supervision Status:  DSUP
NONE
```

Call Progress Detection Command (w/Option .35A or .35C): DCPG

```
DIAL TONE or TRUNK BUSY or LINE BUSY or NO TONE
```

LINE INTERFACE COMMANDS (continued)

Dial Commands:

Universal Dial Command:

```
DIAL  XXN      ,DPS[21]            ,YY...YY    (0-9,+,-)[12] or
               DTMF[15]                        (0-9,*,#,A-D,+,-)[12]
               MF[15]                          (0-9,E,T,K,P,S,+,#,-)[12]
where 01≤XX≤47
(register #)  (addressing type)  (up to 40 digits)

ONHOOK[1,12], or RING[14], NORM[2] or REV, HOLD[1,19], GEN[1] or TPT[1],
  ON                        N       R     H        G
                        (line reversal) (hold) (generator) (TPT detect)

LINE or EQPT,   WINK[1],   FXOLS[1],   I,      VF[1],   SON or SOFF
                           FXOGS
                           FXSLS
                           FXSGS
(E&M dir)  (wink enable)  (FX) (no idle) (analog) (onhook)
```

Pulse Signaling Dial Command:

```
SDPS     NORM[2] or REV,    XX...XX[7] or ONHOOK[1,9,19]   HOLD[1,19]
           N       R                       ON               H
        (line reversal)  (40 digits)                     (hold)

LINE or EQPT,                TPT[1]
(dialing direction, E&M)  (TPT detect)
```

DTMF Signaling (Option .60) Dial Command:

```
SDTT  NORM[2] or REV, XX...XX[7] or ONHOOK[1,9], HOLD[1,19], GEN[1] or TPT[1]
        N       R                   ON         H          G
      (line rev)  (40 digits,0-9,*,#,A-D)  (hold)  (gen) (TPT detect)
```

LINE INTERFACE COMMANDS (continued)

MF Signaling (Option .60) Dial Command:

SDMF NORM[2] or REV, XX...XX[7] or ONHOOK[1,9], HOLD[1,19], GEN[1] or TPT[1]
N R ON H G
(line rev) (40 digits, 0-9) (hold) (gen) (TPT detect)

CCITT R1 MF Digit	Freq	ASCII Characters
Code 11	700 & 1700	E
Code 12	900 & 1700	T
KP1	1100 1700	K
KP2	1300 & 1700	P
ST	1500 & 1700	S

DTMF/MF Send Level Commands (Option .60)

DTMF/MF Send Level Setup:

SMFL ±XX.XDBM
-0.0DBM[23]
(send level +10.0≥XX.X≥-70.0)

Display DTMF/MF Send Level Setup: DMFL

±XX.XDBM

Receive Digit Setup Commands (w/Option .35C only):

SRTT DPS or DTMF or MF, LINE or EQPT, CLEAR
(addressing type) (E&M pulse only) (clear digit buffer)

Display Received Digits Commands (w/Option .35A or .35C): DRTT

DPS or DTMF or MF XX...XX or NO DIGITS RECEIVED
(40 digits)

Clear Receive Digit Buffer: DRTT CLEAR
C

LINE INTERFACE COMMANDS (continued)

Automatic Dial Number Entry Command:

```
SADN  XXN,        DPS,          0-9,+,-[12]
      01N[2]      DTMF[15]      0-9,*,#,A-D,+,-[12]
                  MF[15]        0-9,E,T,K,P,S,+,-[12]
where 01≤XX≤47
   (register #)  (addressing type)       (40 digits)
```

Display Automatic Dial Numbers Command:

```
DADN  XXN
      ALL
(auto dial register #)
XXN*[13]    DPS or DTMF[15] or MF[15]    YY...YY
```

5.6.3 Test Signal Generator Commands

TEST SIGNAL GENERATOR COMMANDS

Level/Frequency Setup Command:

```
SSND  QUIETTERM[1,2] or ±XX.XDBM,  XXX.XXXKHZ or TESTTONE or LBT,
        QT            -0.0DBM[2]     1.00KHZ[2]       TT
                      (level)    (frequency)  (2713 Hz loopback)

      SKIP[1],     1ST
       SK        10ST
      (SF Skip)  100ST  STEP  S
                 1KST
                 10KST (Option .10 only)
                 (step size)
```

Display Level/Frequency Setup Command: DSND

```
QUIET TERM or ±XX.XDBM   XXX.XXXKHZ or TESTTONE
STEP or 1Hz or 10Hz or 100Hz or 1kHz or 10kHz  SKIP
```

Sweep Setup Command:

```
SSWP  ±XX.XDBM,    XXX.XXLL,    XXX.XXHL,    STEP,
      -0.0DBM[2]    0.30LL[2]     3.21HL[2]     S
       (level)   (low limit)  (high limit)  (100 Hz)

      SKIP[1],    HI[2] or MID or LO,    UP or DOWN or AUTO[2]
       SK          H      M      L       U      D       A
      (SF skip)     (sweep rate)         (sweep direction)
```

Display Sweep Setup Command: DSWP

```
±XX.XDBM    XXX.XXKHZLL    XXX.XXKHZHL   STEP
SKIP       HI or MID or LO  UP or DOWN or AUTO
```

5.6.4 Level, Frequency, S/N Ratio Measurements

LEVEL, FREQUENCY, S/N RATIO MEASUREMENTS

Level Setup Command:

```
SLVL  ABS[3] or ±XXTLP,  SN[1] or DAMP[1],    HPF[1,5],   SET0[1,19]
                ±0TLP[2]          D             H
          (TLP set)   (S/N or damping) (hp filter) (ref.set)
```

Display Level Setup Command: DLVL

```
±XXDBTLP    S/N or DAMP    HPF    SET0
```

Measure Level Command: MLVL

```
3002 or C1 or C2 or C3A or C3T or C4 or C5 or DC[6]
(conditioning mask)
```

Measure Level Command Output Format:

```
±XX.XDBM    XXX.XXXKHZ    XXDBS/N or **DBS/N            PASS
    DBM0    ***.***KHZ    (when S/N out-of-range)       FAIL
    DB        XXXX.XHZ
              ****.*HZ
```

Fast Measure Level Command: MFLV

Fast Measure Level Command Output Format:

```
±XX.XDBM      XXX.XXKHZ
    DBM0      ***.**KHZ
```

5.6.5 Noise Measurements

NOISE MEASUREMENTS

Noise Measurement Setup Command:

```
SNSE  ABS[3] or ±XXTLP,  CMSG[2] or CNOTCH or FLAT or FNOTCH or
              +0TLP[2]      C         CN        F       FN
             (TLP set)            (noise weighting filters)

      15FLAT[20] or 15FNOTCH[20] or PRGM[20] or PRGMNOTCH[20] or 50KB[20] or
        15F           15FN                      PRGMN

      50KBN[20],  DAMP[1],  NTG[1]
                    D
                (damping) (noise-to-ground)
```

Display Noise Setup Command: DNSE

```
±XXDBTLP   CMSG or CNOTCH or FLAT or FNOTCH or 15FLAT or

15FNOTCH or PRGM or PRGMNOTCH or 50KB or 50KBNOTCH  DAMP NTG
```

Measure Noise Command: MNSE

Measure Noise Command Output Format:

```
±XX.XDBRN
     DBRN0
     DBRNC
     DBRNC0
```

5.6.6 Impulse Noise Measurements
(Option .11)

IMPULSE NOISE MEASUREMENTS

Impulse Noise Setup Command:

SIMP XXXLTH BELL or FAST, XSPREAD, CMSG or CNOTCH2 15FLAT[20]
or
-68LTH[2] B F 4S[2] C CN 15F
(low threshold) (count rate) (spread)

15FLATNOTCH[20] or PRGM[20] or PRGMNOTCH[20] or 50KB[20] or 50KBN[20]
15F PRGMN
(noise weighting filters)

Display Impulse Noise Setup Command: DIMP

XXXDBMLTH BELL or FAST XDBSREAD CMSG or CNOTCH or

15FLAT or 15FNOTCH or PRGM or PRGMNOTCH or 50KB or 50KBN

Measure Impulse Noise Commands:

MIMP[10] XXMIN or CONT, YY.YINT[1] (impulse noise)

MIHD[10] XXMIN or CONT, YY.YINT[1] (impulse noise, hits, DO)
(measurement timer) (printer interval)

Measure Impulse Noise Command Output Formats:

XXXXHI XXXXMD XXXXLO XXXX.XMIN*[4] NO TONE

5.6.7 Hits and Dropouts Measurements
(Option .13)

HITS AND DROPOUTS MEASUREMENTS

Hits and Dropouts Setup Command:

```
SHDO      XXDEG,      XXDB,      BELL[2] or FAST,      TEST[1,5,8]
          5DEG[2]     2DB[2]     B       F             T
        (phase hit) (gain hit) (count rate)  (test source)
```

Display Hits and Dropouts Setup Command: DHDO

```
        XXDEG   XXDB   BELL or FAST   TEST
```

Measure Hits and Dropouts Commands:

```
MHDO[10]    XXMIN or CONT,      YY.YINT[1]    (hits and dropouts)

MIHD[10]    XXMIN or CONT,      YY.YINT[1]    (impulse noise, hits, DO)
          (measurement timer) (print interval)
```

Measure Hits and Dropouts Command Output Formats:

```
XXXXPH    XXXXGH    XXXXDO    XXXX.XMIN*[4]    INV SIG
```

5.6.8 Envelope Delay Measurements
(Option .12)

ENVELOPE DELAY MEASUREMENTS

Delay Setup Command:

```
SDLY  MASTER[2] or SLAVE or SLAVEAMP,  RCV[2] or SEND,  ABS[3] or ±XXTLP
        M          S         SA                          ±0TLP[2]
      (master/slave/slave + amp)   (displayed freq)   (TLP set)

        DAMP[1]          ZERO[1,11]                SET0[1]
          D                Z
      (damping)  (delay zero reference)  (level zero reference)
```

Delay Setup Command: DDLY

```
MASTER or SLAVE or SLAVEAMP  RCV or SEND  ±XXDBTLP  DAMP  SET0
```

Measure Delay Command: MDLY

```
3002 or C1 or C2 or C3A or C3T or C4 or C5
(conditioning mask)
```

Measure Delay Output Command Formats:

```
±XX.XDBM   PASS[24]   XXX.XXXKHZ   ±XXXXUS    PASS
   DBM0    FAIL                   INV LEVEL   FAIL
   DB                             INV SIG     FAST
```

5.6.9 Amplitude Jitter Measurements
(Option .13)

AMPLITUDE JITTER MEASUREMENTS

Amplitude Jitter Setup Command:

```
SAMJ  BELL[2] or BLF,                TEST[1,5,8]
        B                              T
      (jitter frequency range)   (self-test)
```

Display Amplitude Jitter Setup Command: DAMJ

```
BELL or BELL+LF   TEST
```

Measure Amplitude Jitter Command: MAMJ

Measure Amplitude Jitter Command Output Format:

```
±XXDBM    XXX.XXXKHZ    XX.X%PEAK
```

5.6.10 Phase Jitter Measurements
(Option .13)

PHASE JITTER MEASUREMENTS

Phase Jitter Setup Command:

```
SPHJ  BELL[2] or BLF,                TEST[1,5,8]
        B                              T
      (jitter frequency range)   (self-test)
```

Display Phase Jitter Setup Command: DPHJ

```
BELL or BELL+LF   TEST
```

Measure Phase Jitter Command: MPHJ

Measure Phase Jitter Command Output Format

```
±XXDBM    XXX.XXXKHZ    XX.XDEGP-P
```

5.6.11 Intermodulation Distortion Measurements (Option .14 or p/o .30)

INTERMODULATION DIST. MEASUREMENTS

Intermodulation Distortion Setup Command

```
SIMD  SNT[1,5]              TEST[1,5,24]
                              T
      (send 2 tones)  (self-test)
```

Display Intermodulation Distortion Setup: DIMD

```
SNTEST or TEST
```

Measure Intermodulation Distortion Command: MIND

```
DC
(D-conditioning)
```

Measure Intermodulation Distortion Command Output Format

```
±XXDBM   XXDB2ND   XXDB3RD   RCV SNTEST   PASS
±XXDBM   SPURIOUS                         FAIL
         INV LEVEL                        ****
```

5.6.12 P/AR Measurements (Option .18, .18A, or p/o .30)

P/AR MEASUREMENTS

P/AR Setup Command:

```
SPAR   DAMP[1],     TEST[1,5]
         D            T
      (damping)  (self-test)
```

Display P/AR Setup Command: `DPAR`

```
DAMP   TEST
```

Measure P/AR Command: `MPAR`

Measure P/AR Command Output Format

```
±XXDBM    XXXP/AR   UNITS   INV LEVEL
```

5.6.13 Return Loss Measurements
(Option .16)

RETURN LOSS MEASUREMENTS

Return Loss Setup Command

```
SRLS    ERL or ERLCMSG or SRLLO[2] or SRLHI or SINE,    ZERO[1]
                                SRL                       Z
                          (test signal)              (zero reference)
4W2 or 2W600 or 2W900 or 2W1200 or 2WEXT, DAMP,±XX.XTHL
        2W6      2W9      2W12              D
(4W/2W impedance select)                (damping)(transhybrid loss)
```

Display Return Loss Setup Command: DRLS

```
ERL or SRLLO or SRLHI or SINE  4W or 2W600 or 2W900 or 2W1200 or 2WEXT
DAMP    ±XX.XTHL
```

Measure Return Loss Command: MRLS

Measure Return Loss Command Output Format

```
±XXDBM    ±XXDBRLOSS  (for ERL, SRLLO, SRLHI)
           ***DBRLOSS  (for zero reference, not set)
±XXDBM    XXX.XXXKHZ  ±XXDBRLOSS  (for SINE)
```

5.6.14 VOM/CAP Measurements (Option .40)

VOM/CAP MEASUREMENTS

VOM/CAP Setup Command

```
SVMC  VDC[2] or VAC or MADC or MAAC or RES or RESH or CAP or CAPH,
                       ADC     AAC    RESL           CAPL
                    (measurement selections)
      TR[2] or TS or RS,          NORM[2] or REV
                                    N       R
      (input configuration)    (line reversal)
```

Display VOM/CAP Setup Command: DVMC

```
VDC or VAC or MADC or MAAC or RESL or RESH or CAPL or CAPH,
TR or TS or RS    NORM or REV
```

Measure VOM/CAP Command: MVMC

Measure VOM/CAP Command Output Formats

```
±XX.XVDC or ±XXXVDC or ++++VDC or ----VDC
XX.XVAC or XXXVAC or ++++VAC
±XX.XMADC or ±XXXMADC or ++++MADC or ----MADC or OVERLOAD or BAD FUSE
XX.XMAAC or XXXMAAC or ++++MAAC or OVERLOAD or BAD FUSE
0.XXXKOHM or X.XXKOHM or XX.XKOHM or 0.XXXMOHM or X.XXMOHM or
XX.XMOHM or ++++KOHM or ****KOHM
X.XXµFD or XX.XµFD or ++++µFD or ****µFD or BAD FUSE
BAD CAL0
BAD CAL5
```

5.6.15 ESF PCM Commands (Option .64)

ESF PCM MEASUREMENTS

PCM Setup Command

```
SPCM  OFF[1] or INLINE[2], AMI[2],  D3D4[2],        TANDEM[16],  REMCOM[1]
                           B8ZS,    SL96            THRU[2]      SREMCOM
                                    ESF
                                    D1D
                                    D2
            (mode)  (line code)(chan format)(alarm mode)  (rem com)

or EXT[1,16]  AB[2],  DI[1],  FRE[2],  TOE[2],    XXCH,       T[2],  FDL[1,16] or
              SF      MON[2]  FRW      TOW        01CH[2]     B
              NONE              CONF[17]  01≤XX≤24
(ext int)(PCM sig)(DI)(rcv dir)(DI dir)(chan #)(PCM term)(FDL D&I)

or TRML,  AMI[2]          D3D4[2],        0.3S[18],
                          ESF
                          D1D             2.6S
          B8ZS,           D2              NOALM[16]
(mode)(line code)(frame format)  (alarm delay)

SLAVE[2,18] or MASTER,    AB[2],   DI[1,18],   DTOD[2],      FRE[2],
  S             M         SF       IDLE[2]     ATOD          FRW
                                    NONE        LOOP[16]      DTOA
                                                AIS[16]
                                                RALM[16]
                                                PTRN[27]
(send clock)     (PCM signaling) (D&I) (arrangement) (rcv dir)

TOE2,      XXCH,       EAST[18],     REMCOM[1] or EXT[1,16],   T2 or
TOW        01CH[2]     WEST[18]      SREMCOM                   B
CONF17     01≤XX≤24
(D&I dir)  (chan #)  (adv mode dir)(remote com)(ext int)  (PCM term)

or DCS,    AMI[2]    0.3S,      AB[2],   DI[1],    FRO[2],  TOO[2],  FDL[1,16]
                     2.6S       SF       MON[2]    FRE      TOE
           B8ZS,     NOALM[2,16] NONE    PTRN[27]           CONF[17]
(mode)(line code)(alrm del)(PCM sig)  (DI)(rcv dir)(DI dir)(FDL DI)

XXTP,          REMCOM[1] or EXT[1,16],      D3D4,          T[2]
01TP[2]        SREMCOM                      ESF            B
01≤XX≤12
(test port #)(remote com)(ext int)(framing format)(PCM term)
```

ESF PCM MEASUREMENTS

Display PCM Setup Command: DPCM

```
ON or OFF      INLINE or TRML or DCS
B8ZS or AMI      D3D4 or D1D or D2 or ESF or SL96
AB or SF or NONE      FROMEAST or FROMWEST
TOEAST or TOWEST or CONF
FROMODD or FROMEVEN      TOODD or TOEVEN or CONF
XXCH or XXTP           DTOD or ATOD or DTOA      TANDEM or THRU
EXT or REMCOM or SREMCOM          T or B         FDL
EAST: and WEST:      MASTER or SLAVE      0.3S or 2.6S or NOALM
MON or IDLE or DI or LOOP or AIS or RALM
```

PCM Signaling Setup Command:

```
SPCS   AB[2],      VXYZE or VXE, VXYZ0 or VXW, VXYZW or VXO,  VXYZE or VXE
       SF               ONE           ONW           ONO            ONE
                        OFFE          OFFW          OFFO           OFFE
(PCM sig type)  (inline+term supervision) (DCS supervision)

     WINK[1]
   (wink gen)    (V=A bit, X=B bit, Y=C bit, Z=D bit, 0, 1, or X)
```

Display PCM Signaling Command: DPCS

```
INLINE or TRML modes:

AB TO      VXYZE or VXE   VXYZW or VXW
AB FROM    ENOPCM or EFRALM or ERFALM or EAIS    VXYZE or VXE
           WNOPCM or WFRALM or WRFALM or WAIS    VXYZW or VXW

SF TO      ONE or OFFE    ONW or OFFW
SF FROM    ENOPCM or EFRALM or ERFALM or EAIS    ONE or OFFE
           WNOPCM or WFRALM or WRFALM or WAIS    ONW or OFFW
           (where  V=A bit, X=B bit, Y=C bit, Z=D bit;  0 or 1)
```

ESF PCM MEASUREMENTS (continued)

DCS mode:

```
AB TO    VXYZO or VXO    VXYZE or VXE
AB FROM  NOPCM or FRALM or RFALM or AIS    VXYZO or VXO   VXYZE or VXE

SF TO    ONE or OFFO   ONE or OFFE
SF FROM  NOPCM or FRALM or RFALM or AIS    ONO or OFFO    ONE or OFFE
         (where  V=A bit, X=B bit, Y=C bit, Z=D bit;  0 or 1)
```

Measure PCM Performance Command:

```
MPCM,   XXXHR  YY.Y,     RPT,     EAST,       STOP,
                                  WEST
     (meas timer)  (30sec repeat) (dir)  (terminate test)
where: 100≥XX.X≥0 hours, 59.9≥YY.Y≥0.0 min

MFE   (Multiframe Bit Errors, superframe only)
BPV   (Bipolar Violations)
ERS   (Errored Seconds))
FRE   (Frame Bit Errors)
FRA   (Frame Alignment Alarms)
EX0   (Excessive Zeroes)
RFA   (Remote Frame Alignment Alarms)
NPA   (No PCM Alarms)
CRC   (CRC Errors, ESF only)
```

Measure PCM Performance Command Output Format:

```
XXX:YY.Y*4 ELAPSED TEST TIME
XXXX EAST BP VIOLATIONS
XXXX EAST ERRORED SECS
XXXX EAST FRAME ERRORS
XXXX EAST FRAME ALARMS
XXXX EAST EXCESS 0'S
XXXX EAST REMOTE ALARMS
XXXX EAST NO PCM ALARMS
XXXX EAST CRC ERRORS (ESF only)
XXXX EAST MFAS ERRORS (superframe only)
```

5.6.16 Responder Interface Measurements
(Option .52)

RESPONDER INTERFACE MEASUREMENTS

Responder Interface Setup Command:

```
SRSP  TEST[2] or RSLE[1] or SCHK,
            (release) (selfcheck)
4W or 2W600 or 2W900 or 2W1200 or 2WEXT
       2W6      2W9      2W12
     (2W/4W select and 2W impedance)
```

Display Responder Interface Setup Command: DRSP

```
TEST or SCHK    4W or 2W600 or 2W900 or 2W1200 or 2WEXT
```

Display TPT (Test Progress Tone) Detection Command: DRSP TPT

```
NO TPT or TPT or TPT REMOVED
```

Measure Responder Interface Command:

```
MRSP  LOSS[2] or GS04 or GS10 or GS28
      (gain slope, 0.4, 1.0 and 2.8 kHz)

      NWT or NEN or FEN or SRLLO or ERL or SRLHI or ALL
      (noise w/tone)(near-end noise)(far-end noise)(return loss)
```

Responder Interface Command Output Formats

```
±XX.XDBM    FN  ±XX.XDBM     NF  LOSS or GS04 or GS10 or GS28   SCHK
±XX.XDBM0   FN  ±XX.XDBM0    NF  LOSS or GS04 or GS10 or GS28   SCHK
XXDBRNC     FN    XXDBRNC     NF   NWT   SCHK
XXDBRNC0    FN    XXDBRNC0    NF   NWT   SCHK
XXDBRNC     NEN or FEN  SCHK
XXDBRNC0    NEN or FEN  SCHK
±XXDB       FN  ±XXDB         NF   ERL or SRLLO or SRLHI   SCHK
±XXDB       FN  NOT EQUIPPED  NF   ERL or SRLLO or SRLHI   SCHK
TPT
NO TPT
```

Response of Dial Command with TPT Detect Command: DIAL TPT

```
NO TPT (or no response if TPT is detected)
```

5.6.17 T1 Bit Error Ratio Measurements
(Option .65)

T1 BIT ERROR RATIO MEASUREMENTS

T1 Bit Error Ratio Setup Command:

```
SBER    2E9    or  511,     PRMRY[2] or CHNNL,
        2E11   or  2047
        2E15
        2E20
        2E23
        QRSS[2]
        ALL1
        3IN24
        XXXXXXH
       (pattern)          (T1 or channelized rate)
(where XXXXXXH is user data pattern of 8, 16, or 24 bits in hex)

        B8=1 or CLR,          FRMD[2] or UNFR,
       (56kbps or 64 kbps)      (format)
        SLAVE or MASTER,      XE-YBE or XXBE
                                  0BE (turns off)
          S        M          (where X=1, 2, 5; Y=3-9; 1≤XX≤99)
       (send clock source)   (bit error injection)

        XE-YBPV or XXBPV[1],     XE-YFRBE or XXFRBE[1],
           0BPV (turns off)        0FRBE (turns off)
        CSUUP[1] or SMJUP[1] or RDLUP[1], LINE[1] or PLD[1],
        CSUDN[1]    SMJDN[1]    RDLDN[1]
       (CSU,SMJ, or RDL loopback)  (line or payload loopback)

        XXSEC,          EWCLK[2] or EICLK,       1HZ[2] or 0.1HZ
        30SEC[2]
   (where 5≤XX≤30)
  (loopback timeout) (freq diff meas clock) (freq diff resolution)
```

Display T1 BER Command: DBER

```
511 or 2047 or 2E15 or 2E20 or 2E23 or
QRSS or ALL1 or ALT or 3IN24 or
XXXXH PRMRY or CHNNL B=1 or
CLR FRMD or UNFR SLAVE or MASTER
XE-YBE or XE-YBPV or XE-YFRBE
0.1HZ or 1HZ    XXSEC
```

Measure Bit Error Ratio Command: MBER

T1 BIT ERROR RATIO MEASUREMENTS (continued)

Measure Bit Error Ratio Command Output Format:

```
0:00.5*  ELAPSED TIME
FREQUENCY DIFFERENCE:  0Hz
                                    COUNT                    RATIO
BIT ERRORS:                           0                    0.00E  0
BPVs:                                 0                    0.00E  0
FRAME ERRORS:                         0
MFAS ERRORS:                          0
CRC ERRORS:                    N/A
NO PCM ALARMS:                        0
EXCESSIVE ZEROS:                      0
REMOTE ALARMS:                        0
PATTERN SLIPS:                      N/A
FRAMING SYNC LOSSES:                  0                      0.0SEC
PATTERN SYNC LOSSES:                  0                      0.0SEC
                                  ASYNC                    SYNC
ERRORED SECONDS:                      0                        0
SEVERELY ERRORED SECONDS:             0                        0
DEGRADED MINUTES:                     0
UNAVAILABLE SECONDS:                  0
ERROR FREE SECONDS:             100.000%                 100.00%
```

Display Error Log Contents Command: DLOG

Display Error Log Contents Command Output Format:

```
DLOG   DATE        TIME     INTV  BERR    EVENT
     10/24/89   13:40:25    2    3813  BERR, FRBE, SES
     10/24/89   13:39:03    1    36    BERR, FRMSYNC
```

Display the Number of Stored 15 Minute Intervals Command: DINT

```
DINT   XXX
(where 0≤XXX≤400)
```

Display Stored 15 Minute Interval Test Results Command:

```
DIND   XXX
(start at interval XXX; no entry, XXX=1)
(where 1≤XXX≤400)
DINT
DIND INTV  DATW TIME    PSYNC ERRSEC SES UNAVS DEGMIN BERR BPV FRBE
     1 10/24/89 13:39:32 3     2     2    0      0    72   74  36
     2 10/24/89 13:54:32 3     5     3    0      0    ++++ 68 220
```

FOOTNOTES FOR PARAGRAPHS 5.6.1 THROUGH 5.6.17.

* Option .25A-232 only, not functional on Option .25A-488
1 "momentarily" omitting turns function off
2 default parameter value at power up
3 if ABS is true, then TLP=0 dBm up
4 timer is active if "*" is present
5 SGTL turns function off
6 "DC" refers to D-conditioning; only valid when S/N is true
7 entering a - causes a one-second delay
8 self-test for readings of PJ 21.4 ±1.3°, AJ 18.6 ±1.1%
9 before receiving incoming ring, an ONHOOK command must be sent to avoid permanent damage
10 see paragraph 5.6.6
11 ensure that the delay modules have been active, with the forward and return signals applied, at both ends for a minimum of five seconds before sending a delay zero reference command
12 entering a - causes a one-second delay; a + causes a wink detection with Option .35A or .35C
13 currently selected automatic dial number register is indicated by *
14 only use for FX office sequences
15 Option .60 required
16 advanced mode parameter
17 remote communication mode only
18 independently set for east and west; causes adv mode
19 not valid in E&M signaling or NONE
20 Option .15, .15B, or .15C Noise Filters required
21 not valid in NONE
22 if PCM is on and in DCS mode when SCLR W occurs, PCM stays on and remains in DCS mode; all other parameters are cleared
23 DTMF/MF defaults to the current send level until the first SMFL command is received
24 attenuation distortion conditioning printed only if SET) and DDLY RCV are true
25 self-test for reading of 59 P/AR units with Revision 12 or later firmware
26 self-test for reading of 35 dB 2nd and 35 dB 3rd order products with Revision 12 or later firmware
27 available only when Option .65 T1 BER is installed. Activates the Option .65.

5.6.18 EasyTest™ Procedure Commands

EasyTest™ procedures are programmed routines that contain procedural language commands. (For information on procedural language, refer to the EasyTest™ Editor User's Manual, HKMN 103-377-200.) These procedures enable you to perform a complex test procedure by entering one command.

A CTS equipped with Option .25A includes a basic set of EasyTest™ procedures, Option .71-001. Additional procedures can be added by ordering Options .71-002 Master/Slave EasyTest™. Also available is Option .72, EasyTest™ Editor. This option enables you to create, test, and modify EasyTest™ procedures.

The following paragraphs provide:

- An example of an EasyTest™ procedure
- A reference list of basic, optional master/slave, and enhanced EasyTest™ procedures
- Definitions of basic, optional master/slave, and enhanced EasyTest™ procedures.

5.6.18.1 EasyTest™ Procedure Example

An EasyTest™ procedure is a programmed routine made up of procedural language commands. The entire routine is performed by entering one command. For example, EasyTest™ procedure SEQ2 performs the following tests in response to the command PROC SEQ2:

- Impulse Noise
- Hits
- Phase Jitter
- C-Notch Noise
- Level/Frequency

The procedure performs the tests for a specified period of time and reports results during the measurement. The CTS must be receiving 1 kHz test tone for this test.

The procedural language commands that make up the SEQ2 procedure are shown in Figure 5-4. Figure 5-4 also shows a sample result of the SEQ2 procedure. The SET procedure is also used in the example to set the send level and frequency and terminate the line.

SAMPLE PROC LISTING OF SEQ2 (SEQUENCE 2)

```
->LIST SEQ2
  PROC SEQ2
  SLVL
  WAIT F .99LL 1.Ø3HL T=5SEC
  IF TIMEOUT
    MSG INVALID SIGNAL
    EXIT
  ENDIF
  MIHD *P1MIN *P2INT
  SNSE CN
  MPHJ
  MNSE
  MLVL
  END

->
```

Operator uses LIST command to examine the contents of PROC SEQ2.

5-second wait for presence of 1-kHz test tone.

P1 and P2 are variable labels for the input parameters of measurement timer and print interval for the measure impulse noise, phase hits, gain hits and dropouts command.

Measurements of phase jitter, C-Notch noise, and level/frequency.

EXAMPLE OF THE OUTPUT OF PROC SEQ2
PROVIDING MEASUREMENTS ON A CHANNEL WITH TEST TONE.

```
->PROC SET ^-1Ø;1.Ø

->PROC SEQ2  ^2;1
     ØHI       ØMD       ØLO       1.ØMIN*
     ØPH       ØGH       ØDO       1.ØMIN*
     ØHI       ØMD       ØLO       2.ØMIN
     ØPH       ØGH       ØDO       2.ØMIN
  -1ØDBM    1.ØØ4KHZ   Ø.1DEGP-P
  11DBRNC
  -1Ø.ØDBM    1.ØØ4KHZ

->
```

393

Operator uses PROC SET to set the send level to -10 dBm, the send frequency to 1.0 kHz, and to terminate the receive side. The " ^ " character defines the parameter inputs which are separated by semicolons and in this instance are level and frequency values.

Operator invokes PROC SEQ2 which performs a measurement of impulse noise, phase hits, gain hits and dropouts, phase jitter, a C-Notch noise measurement, and a level/frequency measurement.

Figure 5-4. EasyTest™ Procedure SEQ2 Listing and Sample Results

5.6.18.2 EasyTest™ Procedure List

Table 5-6 provides a list of basic, optional master/slave, and enhanced EasyTest™ procedures. For definitions of each procedure, refer to the following paragraphs. To display the list of EasyTest™ procedures installed, use the command DIR; the set number and firmware revision level, the directory, and the available RAM buffer size in bytes will display.

TABLE 5-6. EASYTEST™ PROCEDURES LIST

.71-001 BASIC EASYTEST™ PROC SET	.71-001 MASTER/SLAVE EASYTEST™ PROC SET	.71-007 ENHANCED EASYTEST™ PROC SET DATA TESTING PROCS
3TONE	DMAST	ALL
829	MADD	MAST3TS
LLFSWP	SETM	MASTIHD
MWQ		MASTIMD
RXFSWP		MASTNSE
SEQ1		MASTPAR
SEQ2		MASTPHJ
SET		MSAD
T125		SETM

5.6.17.3 EasyTest™ Procedure Descriptions

The following descriptions are listed alphabetically by procedure name. Parameters and examples are provided as necessary.

ALL: This procedure executes the amplitude and delay sweeps, noise, intermodulation distortion, 3-tone slope, phase jitter, and P/AR tests in sequence.

Parameters:
P1) Not used
P2) Not used
P3) Master line configuration
P4) Slave line configuration

Parameters 3 and 4 contain the configuration information (2-wire/4-wire). If a test is invoked and parameters 3 and 4 have never been set, the EasyTest™ sets either unset parameter to 4-wire. The default to 4-wire makes the changes from previous versions transparent to a former user. The following configurations may be specified:

2: 2-wire using Model 3700's 2-wire jack (send jack)
4: normal 4-wire operation
12: 2-wire using the receive jack
14: 4-wire connected to a 2-wire unit

It is recommended (particularly with "Slave" units) that any 2-wire installation be made in the receive jack so a power hit does not render a "Slave" incapable of receiving commands.

3TONE: This procedure is used to send three frequencies, 0.4 kHz, 1.0 kHz, and 2.8 kHz in a fixed and repetitive format.

Parameters:
P1) Send level
P2) Number of times to repeat sequence
P3) Time interval between tone changes.

Example: PROC 3TONE A-10;3;5 sends three tones three times at -10 dBm and holds each tone five seconds before going to the next.

829: This procedure enables an 829-type loopback device by sending a 2.7 kHz tone for a user-specified number of seconds. The procedure then sends a 1.0 kHz tone and measures the level of the looped signal.

Parameters:
P1) Send level
P2) Not used
P3) Response wait

Example: PROC 829 A-10;;3 sends all signals at -10 dBm and waits three seconds after sending the 2.7 kHz tone before switching to the 1.0 kHz tone and makes the looped measurement.

DMAST: This procedure sequences the master/slave operation of the CTSs through the D-conditioning tests. It then evaluates the measurements to determine if the line passes or fails in both directions.

Parameters: None required

LLFSWP: This procedure performs a looped level and frequency sweep, skipping the frequencies 2.6 kHz and 2.7 kHz. It sends the selected first tone, waits the indicated time, and then takes a level and frequency measurement. The procedure then repeats at the next 100 Hz interval until the selected end frequency has been completed.

Parameters:
P1) Starting sweep frequency (in counts of 100 Hz)
P2) Ending sweep frequency
P3) Stabilization period

Example: PROC LLFSWP A5;30;3 sweeps from 0.5 kHz to 3.0 kHz skipping 2.6 kHz and 2.7 kHz, allowing three seconds for the line to stabilize between frequency change and the next measurement.

MADD: This procedure gives a common entry point for all types of C-conditioning sweeps. It operates the same as PROC ADCCON, but allows the user to select either attenuation, delay, or both distortion measurements.

Parameters:
P1) Sweeps to perform (A = attenuation, D = delay, AD = both)
P2) C-conditioning mask for 3701/3703/3705/3707 (3002, C1, C2,

C3A, C3T, C4, C5) or for 3702/3706 (1020, 1025, 1040)
P3) Slave end stabilization time

Example: PROC MADD AD;C2;3 performs a delay distortion sweep in both directions, applying the C2 conditioning mask and allowing the line under test to stabilize for three seconds before a measurement is taken.

MAST3TS: This procedure executes the Master/Slave controlled 3-tone slope test sequence included in the Enhanced REACT 2000 EasyTest™. This is a dummy entry into MCOM.

Parameters:
P1) Not used
P2) Not used
P3) Master line configuration
(2, 4, 12, or 14)
P4) Slave line configuration
(2, 4, 12, or 14)

MASTIHD: This procedure executes the Enhanced REACT 2000 EasyTest™ impulse noise, hits, and dropouts tests. This procedure sets up the parameters for entry to MCOM.

Parameters:
P1) Test duration (minutes)
P2) SIMP command parameters
P3) Master line configuration
(2, 4, 12, or 14)
P4) Slave line configuration
(2, 4, 12, or 14)

Example: PROC MASTIHD A2; 6S 70LTH; 2; 2 invokes the Master/Slave impulse noise, hits, and dropouts test for a duration of two minutes using a 6 dB spread and 70 dBrnc low threshold. The line under test is 2-wire, wired into the send jack.

NOTE: The Slave must have the line reversed prior to invoking this procedure. It must be able to receive its first command.

MASTIMD: This procedure executes the Enhanced REACT EasyTest™ intermodulation distortion test at the master end. This procedure is a setup to the common Master/Slave controller MCOM.

Parameters:
P1) Not used
P2) Not used
P3) Master line configuration
(2, 4, 12, or 14)
P4) Slave line configuration
(2, 4, 12, or 14)

MASTNSE: This procedure executes the Enhanced REACT EasyTest™ C-Notch and C-Message noise tests at the master end. This is a dummy entry into the master controller procedure MCOM.

Parameters:
P1) Not used
P2) Not used
P3) Master line configuration
(2, 4, 12, or 14)
P4) Slave line configuration
(2, 4, 12, or 14)

MASTPAR: This procedure executes the master P/AR test sequence. This is a dummy entry into the master controller procedure MCOM.

Parameters:
P1) Not used
P2) Not used
P3) Master line configuration
(2, 4, 12, or 14)
P4) Slave line configuration
(2, 4, 12, or 14)

MASTPHJ: This procedure executes the phase jitter test sequence. This is a dummy entry into the master controller procedure MCOM.

Parameters:
P1) Not used
P2) Not used
P3) Master line configuration
(2, 4, 12, or 14)
P4) Slave line configuration
(2, 4, 12, or 14)

MSAD: This procedure executes the amplitude and delay sweeps. If either end of the test is 2-wire, only amplitude is displayed. The frequencies swept are: 300 Hz, 400 Hz, 500 Hz, and 600 through 3200 Hz in 200 Hz steps. These sweeps form part of the Enhanced REACT 2000 EasyTest™ set.

Parameters:
P1) Not used
P2) Not used
P3) Master line configuration
(2, 4, 12, or 14)
P4) Slave line configuration
(2, 4, 12, or 14)

MWQ: This EasyTest™ performs measurements against the received milliwatt or quiet termination. The tests performed are selected to execute against the proper device.

Parameters:
P1) 0 = device alternates between milliwatt and quiet, to measure level, C-msg noise, and return loss.
1 = device is a milliwatt, so measures level only
2 = device is a quiet termination, so measures C-msg noise and return loss
P2) Send level, if P1 = 0 or 2

RXFSWP: This procedure monitors the receive signal for frequency changes and takes a frequency and level reading every time a stabilized change of 50 Hz or more occurs. If a change of greater than 50 Hz occurs but the frequency does not stabilize to within 10

Hz, the procedure reports NO SETTLED READING. If the variance in frequency is less than 50 Hz after ten seconds, the procedure takes a level reading and appends the message < 50Hz VARIANCE.

Parameters: None required.

SEQ1: This procedure performs the following tests a specified number of times: impulse noise, hits, dropouts, phase jitter, C-Notch noise, and level and frequency.

Parameters:
P1) Length of the integrating measurement test
P2) Number of times to repeat the test sequence

Example: PROC SEQ1 A2;3 performs the integrating measurements for two minutes and then performs the other tests. It repeats this sequence three times.

SEQ2: This procedure performs the same tests as SEQ1, but only performs the sequence once. It performs the test for a user-specified time period (in minutes) and reports results during the measurement.

Parameters:
P1) Length of the integrating measurement in minutes
P2) Update interval

Example: PROC SEQ2 A2; .1 performs the integrating measure for two minutes reporting current counts every 0.1 minute. It then performs the other 3 tests.

SET (.71-001 and .71-002): This EasyTest™ procedure sets some common measurement conditions within the CTS.

Parameters:
P1) Send level
P2) Send frequency
P3) Line configuration

SET (.71-007): This EasyTest™ procedure sets some common measurement conditions within the CTS. This version has been enhanced to support the 2-wire/4-wire mixtures available in the Enhanced EasyTest™ set.

Parameters:
P1) Send level
P2) Send frequency

SETM (.71-001 and .71-002): This EasyTest™ sets some common measurement conditions within both the master and slave CTSs. It requires Option .41 Master/Slave.

Parameters:
P1) Send level
P2) Send frequency

SETM (.71-007): This procedure is used to configure the master and slave CTSs prior to the start of testing. It requires Option .41 Master/Slave.

Parameters:
P1) Send level
P2) Send frequency
P3) Master line configuration
P4) Slave line configuration

Example: PROC SETM 10; 1.0 sets both units to send 1.0 kHz at 10 dBm. Both ends terminate, and if P3 and P4 are not previously specified, that parameter is conserved.

T125: This EasyTest™ performs the control and measurement sequence with a Hekimian Model 125 Transponder (TR).

Parameters: P1) Send level
P2) 2 = 2-wire, 4 = 4-wire, or 12 = 2-wire reversed

TSET: This EasyTest™ presets the CTS prior to the start of the Hekimian Model 125 Transponder test. The parameters set are 1 kHz send frequency, a specified level, the C-Notch noise filter, and the count value (used to store 2-wire/4-wire selection).

Parameters: P1) Send level
P2) 2 = 2-wire, 4 = 4-wire, or 12 = 2-wire reversed

5.7 Error Messages

The Options .25A-232 and .25A-488 use error messages to indicate various problems in the operation of the test set. Each error message is labeled with a number to speed recognition in automated systems. The error messages for the Option .25A-232 and .25A-488 and their descriptions appear in Section 6, Maintenance.

5.8 Remote Communication Mode

When equipped with an Option .25A Remote Control, the CTS can use the VF interface to permit monitor and talk on a channel of the PCM stream via a 2W dial-up line. Refer to Figure 5-5. This mode is valuable when performing remote-control troubleshooting from a central test position.

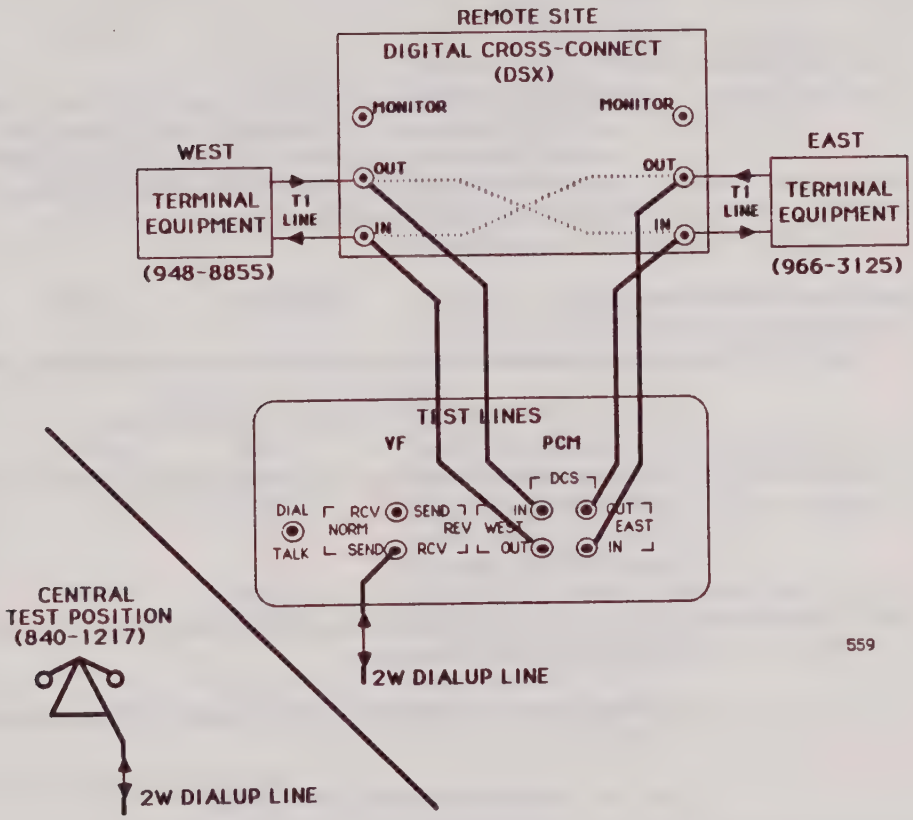


Figure 5-5. Remote Communication In-Line Connection Example

5.8.1 Remote-Communication Connection

The connections to the PCM line interface are made as described in Section 4.4 of this manual. The 2W dial-up line is connected to the CTS VF NORM-SEND (2W) jack.

CAUTION: Application of incoming ring voltage to the CTS VF TEST LINES jacks may cause permanent damage to the test set. Both the VF NORM-RCV and DIAL/TALK jacks should be empty. Do not allow incoming ring to be applied to the SEND jack unless Dial/Talk is active and on-hook has been selected.

When the 2W dial-up line is connected to the SEND jack and is not being used for remote communication, it must be kept in the on-hook state using the following commands:

```
SPCM  REMCOM
DIAL  VF  ON
```

NOTE: The REMCOM parameter is momentary and must be appended to all SPCM commands or it becomes disabled. If REMCOM is omitted, the remote communication with the VF access is disabled, but the VF line is not dropped. Another SPCM REMCOM command reestablishes remote communication.

5.8.2 Remote-Communication Commands

The remote-communication mode is composed of the four functions listed below:

1) Dial on the VF NORM-SEND (2W) jack with PCM active.

2) Listen to the selected PCM channel from either direction separately or from both directions simultaneously.

3) Listen during drop-and-insert.

   A) Listen to the selected PCM channel from either direction separately or from both directions simultaneously.

   B) Listen to the VF signal being encoded onto the PCM channel from the CTS generator.

4) Dial, talk, and listen on the selected PCM channel.

   A) Dial to either direction.

   B) Talk and listen to either direction separately or to both directions simultaneously.

The remote-control commands used to implement each one of these functions are listed in Table 5-7.

NOTE: During operation with the REMCOM parameter, receive SF tones (2600 Hz) are notched out and translated to 2800 Hz. This prevents the 2600 Hz in the PCM channel from dropping the 2W dial-up line if the path contains an SF trunk. During operation with the SREMCOM parameter, the basic unit send side is applied directly to the dial-up line. If the basic unit generator is set near 2.6 kHz and not quiet termination, the dial-up line may drop. The SF tones generated by the Option .62 PCM or .64 ESF PCM to control the PCM channel signaling do not appear on the 2W dial-up line during REMCOM or SREMCOM.

TABLE 5-7. REMOTE CONTROL COMMANDS

COMMAND	PARAMETER	ACTION
DIAL	VF	If PCM and REMCOM are active, this parameter directs the dialing to the VF NORM-SEND (2W) jack. When this parameter is omitted, the dialing will occur on the selected PCM channel.
SPCM	REMCOM	Configures the CTS for the remote-communication mode. This is a momentary parameter and must be included in each SPCM command to remain active.
SPCM	SREMCOM	Configures the CTS to send (on the 2W dial-up line) the VF signal being encoded on the selected PCM channel when drop-and-insert (DI) is also active.
SPCM	TOE TOW CONF	Selects the direction for talk, listen, and drop-and-insert. If CONF is chosen, then listen from both directions in MON, and talk and listen in both directions in drop-and-insert (DI).
SPCM	FRE FRW	Selects the direction to listen from, unless CONF was chosen above in the direction selection. This parameter overrides the default set by the TO parameter.

5.8.3 Remote-Communication Example

Using the connection shown in Figure 5-5, a typical remote communication would occur as follows:

1) Activate the remote-communication mode, and protect the SEND jack.

```
SPCM     REMCOM
DIAL     VF     ON
```

2) Set up the CTS to access the PCM channel in the In-Line mode.

```
SPCM     INLINE        MON    XXCH   REMCOM
```

3) Dial the central test position from the VF NORM-SEND (2W) jack.

```
DIAL     VF     XXXXXXX       HOLD
```

4) Check the supervision status for idle on the PCM channel; listen on channel.

```
DPCS (displays A and B bit status)
```

5) If the channel is idle, seize the circuit and dial in one direction as follows:

A) Set the desired A and B bits in both directions.

B) Activate drop-and-insert to the chosen direction.

C) Dial the distant end in that direction.

```
SPCS  AB     01E   11W
SPCM  DI     TOW   REMCOM
DIAL  XXXXXXX              HOLD (PCM dial)
```

6) Listen for distant end party to answer, then talk. If you wish to test in that direction, activate the desired test after setting the generator send level.

```
SSND     -13DBM      1.5KHZ
MLVL
```

7) To hear the tone being encoded onto the PCM channel:

```
SPCM DI SREMCOM
```

8) To dial in the other direction, once again set up the desired A and B bits and dial:

```
SPCS     AB     11E   11W
SPCM     DI     TOE   REMCOM
DIAL     XXXXXXX      HOLD (PCM dial)
```

9) Listen for the distant end party to answer, then talk. To talk and listen to both parties simultaneously, activate conference.

```
SPCM     DI     CONF  REMCOM
DIAL     VF     HOLD  (re-enters dial/talk mode)
```

10) When the testing is complete, the 2W dial-up line may be dropped and the channel restored.

```
DIAL     VF     ON  (drops the 2W VF interface)
SPCM     MON    REMCOM
```

SECTION 6 - MODEL 3705/3707 MAINTENANCE

CONTENTS

PAGE

6.1 Maintenance Guidelines 6-2
6.2 Corrective Maintenance Procedures 6-2
6.2.1 Fuse Replacement 6-2
6.2.2 Error Message Troubleshooting 6-2
6.2.2.1 Error Messages During Front Panel-Controlled Operation 6-2
6.2.2.2 Error Messages During Remote-Controlled Operation 6-4
6.3 CTS PC Board Replacement Procedures 6-6
6.3.1 Memory/CPU Board Replacement 6-9
6.3.2 4Z I/O Board Replacement 6-10
6.3.3 Remote-Control Board (Option .25A) Replacement 6-11
6.3.4 VOM/CAP Board (Option .40) Replacement 6-13
6.3.5 Call Progress and Signaling (Option .35A and .35C) Replacement 6-13
6.3.5.1 Short Option Board 6-14
6.3.5.2 Long Option Board 6-15
6.3.6 ESF PCM Board (Option .64) Replacement 6-16
6.3.7 Master/Slave Board (Option .41) Replacement 6-17
6.3.8 X-Y Outputs Board (Option .07) Replacement 6-18
6.3.9 T1 Bit Error Ratio Board (Option .65) Replacement 6-19
6.4 Packing, Shipping, and Return to Factory 6-20
6.5 Warranty Information 6-21

FIGURES

6-1 CTS Top Cover Attachment Screws Location 6-7
6-2 CTS PC Boards Location 6-8
6-3 Long Board Extraction 6-9
6-4 CTS RS-232-C DIP Switch Settings 6-12

TABLES

6-1 CTS Error Code Descriptions 6-3
6-2 CTS RAM and EPROM IC Locations on Memory/CPU Assembly 6-3
6-3 CTS Transducer Functions and Addresses 6-4
6-4 CTS Error Message Descriptions (Remote-Controlled Operation) 6-5

6.1 Maintenance Guidelines

Maintenance for the Model 3705 and 3707 Communications Test Systems (CTSs) consists of corrective repairs. No periodic maintenance is required. Corrective repairs are made through replacement of failed modules and PC boards. Replacement procedures and instructions for returning failed equipment for repair are provided in this section.

6.2 Corrective Maintenance Procedures

6.2.1 Fuse Replacement

DANGER: To avoid electrical shock, disconnect primary power before replacing CTS fuse. Replace only with fuse of the specified voltage and current ratings.

The primary power input fuse is located on the right side of the CTS rear panel. The fuse rating requirement is listed on the information plate next to the fuse holder.

6.2.2 Error Message Troubleshooting

The CTS generates error messages indicating either:

- Incorrect operation of the CTS by the user (remote-controlled operation only), or
- A CTS hardware problem.

The content and format of error messages depends on whether the unit is operating through front panel controls or direct-control commands. The following paragraphs describe the error messages for each operating mode.

6.2.2.1 Error Messages During Front Panel-Controlled Operation

During front panel-controlled operation, hardware problem error messages appear on the alphanumeric display in the following format:

`E<XXYY>` (example: `E<1030>`)

The characters within the brackets represent error *codes*. Table 6-1 provides information based on the XX portion of the error code. Referenced in Table 6-1, Tables 6-2 and 6-3 provide additional information based on the YY portion of the code.

TABLE 6-1. CTS ERROR CODE DESCRIPTIONS

XX HEX	DESCRIPTION
00	RAM failure at YY hex[1]
01	EPROM missing at YY hex[1]
02	EPROM located incorrectly at YY hex
03	EPROM checksum error at YY hex
04	EPROM with wrong revision number at YY hex
05	EPROM with wrong revision letter at YY hex
10	Transducer failure at YY hex[2]
21	Background EPROM checksum error at YY hex[1]
22	Loss of foreground activity
30	Illegal RST YY
31[3]	Illegal function, key value YY
32[3]	Illegal external generator, select YY
33[3]	Illegal remote command, command YY
35	DSP generator communications failure
36	T1/CEPT BER command communications failure
37	T1/CEPT BER data communications failure

[1] See Tables 6-2 and 6-3.
[2] See Table 6-3.
[3] These are illegal software conditions detected during execution; these do not relate to a particular board, other than the Memory/CPU board (3701-2004-02).

TABLE 6-2. CTS RAM AND EPROM IC LOCATIONS ON MEMORY/CPU ASSEMBLY

MEMORY	YY HEX	RAM / EPROM IC LOCATION
6264	C0-CF	RAM IC 9
27256	00-7F	EPROM IC 8
	80-BF, E0-FF	EPROM IC 7
27512	00-BF, E0-FF	EPROM IC 7

TABLE 6-3. CTS TRANSDUCER FUNCTIONS AND ADDRESSES

YY HEX	FUNCTION	ASSEMBLY/OPTION
10-1F	Alphanumeric Display	3701-0-3-7
20-2F	Keyboard LEDs	3701-2016-01
30-3F	4Z I/O	3705-2025-01
40-4F	Level Meter	3701-2040-01
50-5F	Frequency Counter	3701-2037-01
60-6F	DSP Generator	3701-2026-01
70-71	Hits/Jitter Option	.13
78-7F	Noise Filters Option	.15, .15A, .15B, .15C
80-83	Envelope Delay Option	.12, .12A
90-9F	Group Delay Option	.17
A0-A1	IMD Option	.14
A2	IMD and P/AR Option	.30
A8-AF	Call Progress Option	.35A, .35C
B0-B3	P/AR and RLOSS Option	.18, .18A
B4	Responder Interface Option	.52
B8-BB	T1 and CEPT BER Option	.65, .66
C0-C3	VOM/CAP Option	.40
D0-DF	PCM Option	.62, .63, .64
F0	Master/Slave Option	.41
F1-F4	X-Y Outputs	.07

6.2.2.2 Error Messages During Remote-Controlled Operation

During remote-controlled operation, error messages display at the control device in the following format:

`ENN AAA AAAA` (example: `E14 RAM FAIL`)

Error codes may also appear as shown in the following message:

`E05 MOD FAIL XXYY` (`XXYY` is the error *code*)

Refer to Table 6-4 for descriptions of error messages displayed during remote-controlled operation. Refer to Tables 6-1, 6-2, and 6-3 for additional information about error codes.

TABLE 6-4. CTS ERROR MESSAGE DESCRIPTIONS (REMOTE-CONTROLLED OPERATION)

MESSAGE	DESCRIPTION
E01 INV CMND	Invalid command; command input syntax error.
E02 INV PARA	Invalid parameter; parameter entry or syntax error.
E03 INV PROC	Invalid procedure; command inhibited; eg., trying to change a line interface parameter during an integrating measurement.
E04 COM FAIL	Interprocessor communications failure.
E05 MOD FAIL XXYY	Module fails to respond on module bus; module may be a basic unit board or option (see Tables 6-1, 6-2, and 6-3).
E06 MOD ABST	Module absent; attempt to access a missing option.
E07 CON PARA	Conflicting parameter; two parameters on the same command line conflict.
E08 INP OVER	Input overrun; entered a command more than 80 characters long.
E10 SLV MODE	CTS in slave mode under control of distant-end master; CTRL-A overrides mode and restores local control.
E11 INC SOFT	Basic unit and remote control firmware types or revision levels incompatible.
E12 MPL PROM	EPROM installed in wrong socket.
E13 MIS SOFT	Mismatched EPROMs in Option .25A.
E14 RAM FAIL	Defective RAM detected on Option .25A during self-test.
E15 BAD CSUM	Defective EPROM detected on Option .25A during self-test.

6.3 CTS PC Board Replacement Procedures

This section contains procedures for replacing various PC boards installed in the CTS. Figure 6-1 shows the locations of screws securing the top cover of the unit. Figure 6-2 shows the locations of PC boards within the unit. Figure 6-3 shows the location of long board extraction notches used to gently raise PC boards from their edge connector seatings.

STEP	REMOVING CTS TOP COVER
	DANGER: Hazardous voltages may exist inside the instrument. To avoid electrical shock, turn POWER switch off and disconnect primary power before proceeding.
1	To remove the top cover from the CTS, remove screws from the sides and top of the unit. (See Figure 6-1.) Set these screws aside for later assembly.
2	Slide the cover to the rear, and remove it from the case.
3	To reassemble, slide the cover on towards the front and install screws set aside earlier in Step 1.

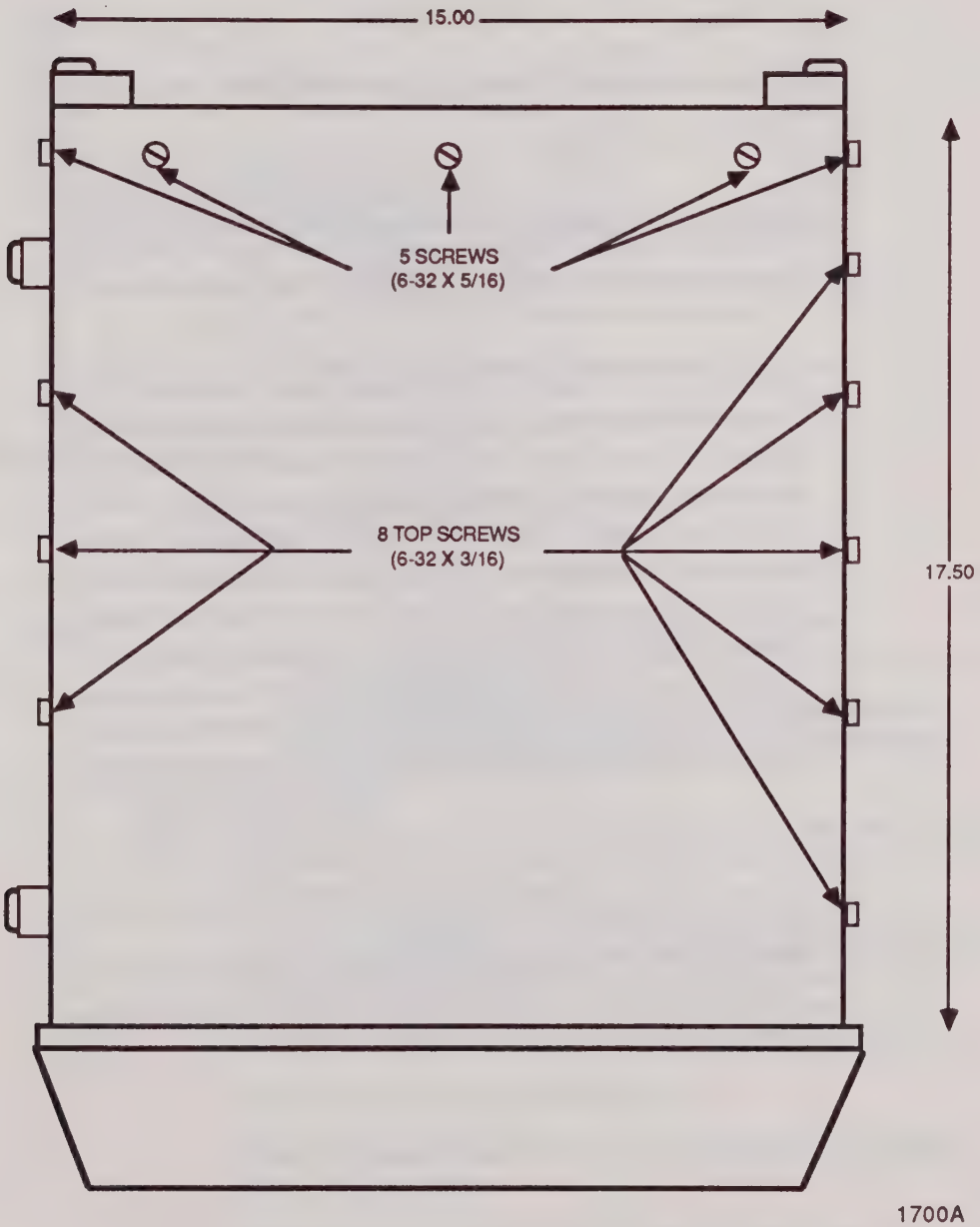


Figure 6-1. CTS Top Cover Attachment Screws Location

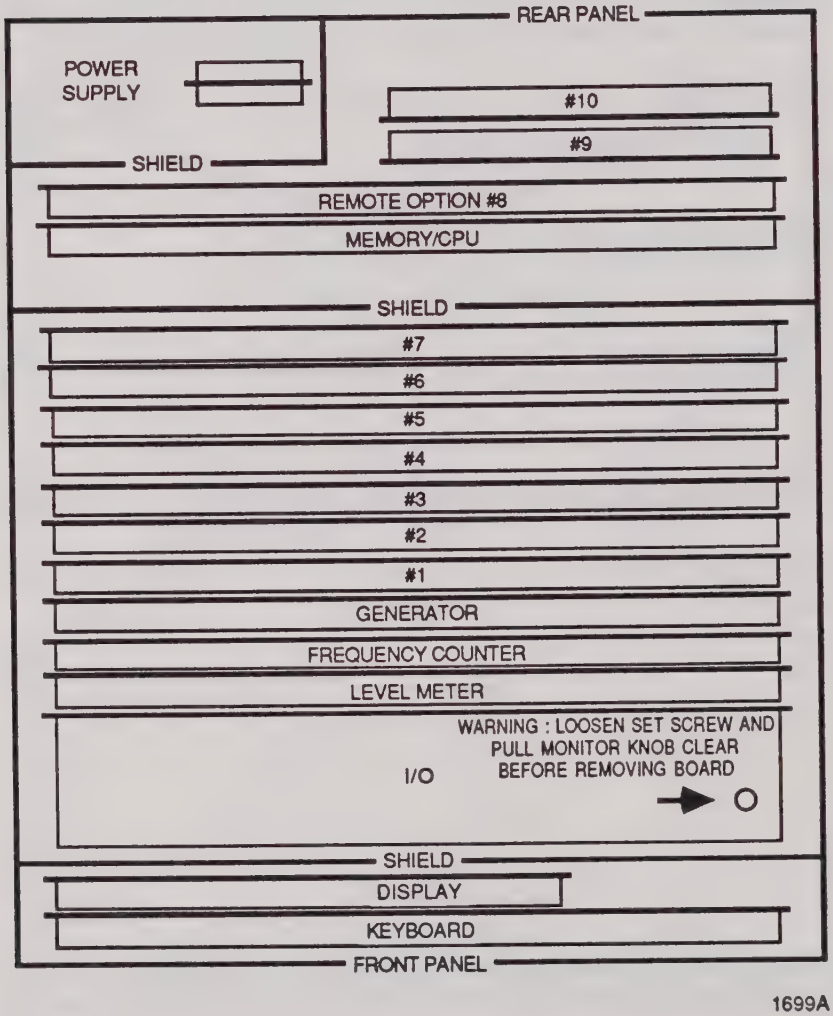


Figure 6-2. CTS PC Boards Location

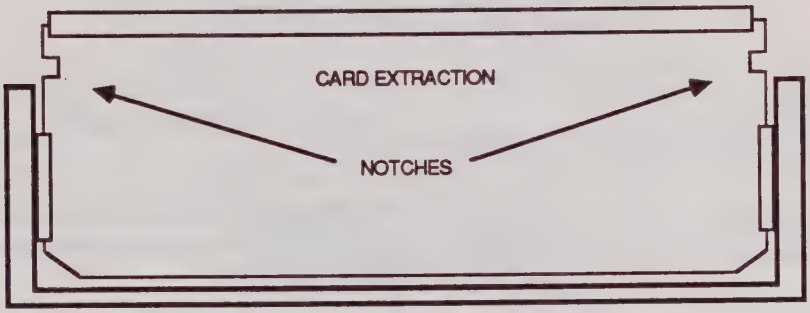


Figure 6-3. Long Board Extraction

6.3.1 Memory/CPU Board Replacement

To replace the Memory/CPU board, proceed as follows:

STEP	REPLACING MEMORY/CPU BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	If Option .64 is installed, unplug cables to connectors J4W and J4E on the ESF PCM board. (These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel.)
2	Using two screwdrivers, gently pry up on the notches found at the side of the Memory/CPU board. Raise the board until connected cables are exposed.
3	Carefully unplug cables at connectors J9 and J10 on the Memory/CPU board.
4	Remove the Memory/CPU board from the CTS.
5	Align the replacement board in the CTS at the Memory/CPU board slot but do not seat the edge connector.
6	Connect cables to connector J9 and J10 on the replacement board.
7	Firmly seat the replacement board in the CTS.
8	Connect the cables to connectors J4W and J4E on the ESF PCM board.

6.3.2 4Z I/O Board Replacement

To replace the 4Z I/O board, proceed as follows:

STEP	REPLACING 4Z I/O BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	Using a 0.05-inch hex wrench, loosen the rear set screw securing the MONITOR knob to the potentiometer on the 4Z I/O board. (See Figure 6-2.)
2	Gently slide the MONITOR knob out so that it does not interfere with removal of the 4Z I/O board.
3	Using two screwdrivers, gently pry up on the notches found on the side of the 4Z I/O board.
4	If Option .40 is installed, unplug the cable at connector J20 on the 4Z I/O board.
5	Remove the 4Z I/O board.
6	Unplug the cable at connector J19 on the 4Z I/O board.
7	Plug cables to connectors J19 and J20 on the replacement board.
8	Gently slide the replacement board into the CTS at the I/O board slot until the edge connector firmly seats.
9	Secure the MONITOR knob to the 4Z I/O board, taking care not to over tighten the set screw.

6.3.3 Remote Control (Option .25A) Board Replacement

To replace the Remote Control, proceed as follows:

STEP	REPLACING REMOTE CONTROL OPTION BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	If Option .64 is installed, unplug cables to connectors J4W and J4E on the ESF PCM board. (These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel.)
2	Carefully unplug the cable from connector J11 on the Remote Control board.
3	If Option .41 is installed, unplug cables from connectors J12 and J23.
4	Using two screwdrivers, gently pry up on the notches found at the side of the Remote Control board.
5	Remove the Remote Control board.
6	Gently slide the replacement board into the CTS at the remote option slot until the edge connector firmly seats.
7	Connect cables to connectors J11, J12, and J23 on the Remote Control board.
8	Connect the cables to connectors J4W and J4E on the ESF PCM board.

Data transmission parameters are set through the RS-232 DIP switch on the rear of the CTS. Check DIP switch settings against settings listed in Table 6-5 below. Correct the DIP switch settings as necessary.

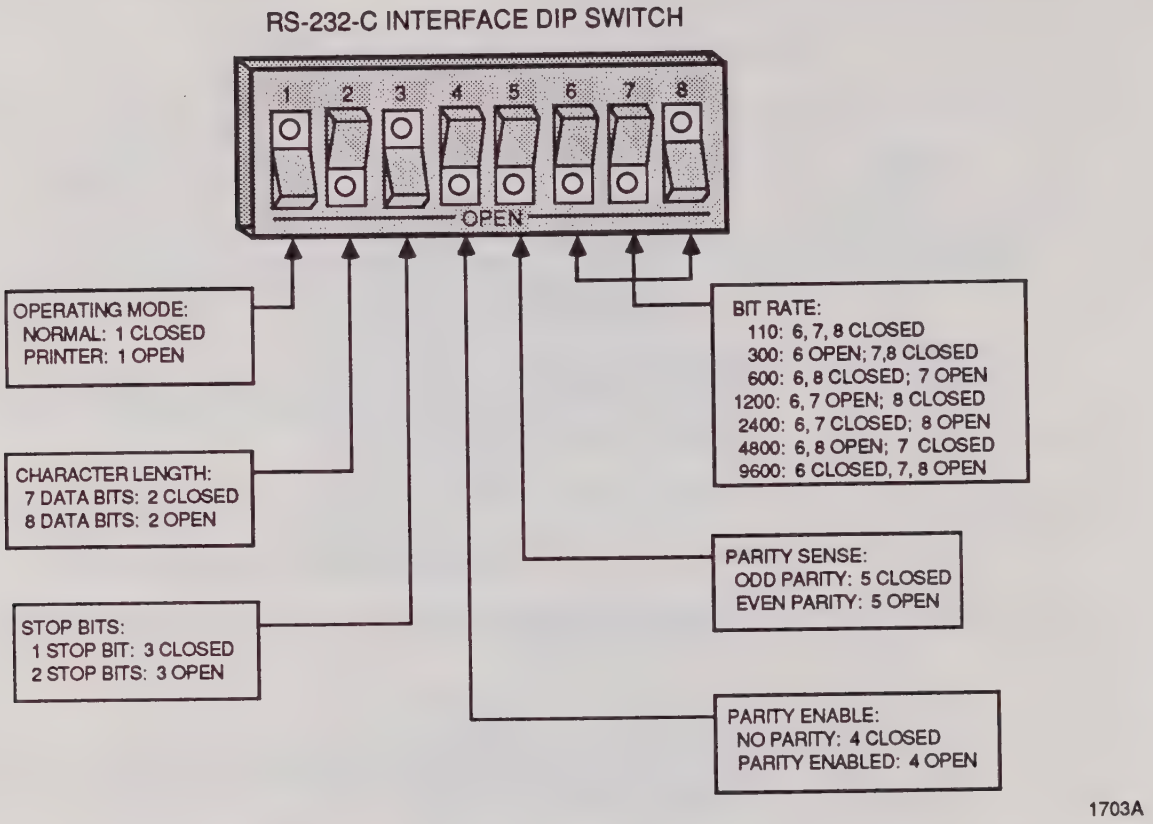

RS-232-C INTERFACE DIP SWITCH
1 2 3 4 5 6 7 8
OPEN
OPERATING MODE:
NORMAL: 1 CLOSED
PRINTER: 1 OPEN
CHARACTER LENGTH:
7 DATA BITS: 2 CLOSED
8 DATA BITS: 2 OPEN
STOP BITS:
1 STOP BIT: 3 CLOSED
2 STOP BITS: 3 OPEN
BIT RATE:
110: 6, 7, 8 CLOSED
300: 6 OPEN; 7,8 CLOSED
600: 6, 8 CLOSED; 7 OPEN
1200: 6, 7 OPEN; 8 CLOSED
2400: 6, 7 CLOSED; 8 OPEN
4800: 6, 8 OPEN; 7 CLOSED
9600: 6 CLOSED, 7, 8 OPEN
PARITY SENSE:
ODD PARITY: 5 CLOSED
EVEN PARITY: 5 OPEN
PARITY ENABLE:
NO PARITY: 4 CLOSED
PARITY ENABLED: 4 OPEN
1703A

Figure 6-4. CTS RS-232-C DIP Switch Settings

6.3.4 VOM/CAP Board (Option .40) Replacement

To replace the VOM/CAP board, proceed as follows:

STEP	REPLACING VOM/CAP OPTION BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	Using two screwdrivers, gently pry up on the notches found at the side of the VOM/CAP board. Raise the VOM/CAP board until the connected cable to the 4Z I/O board is exposed.
2	Unplug the cable at J20 on the left side of the 4Z I/O board, *not* from P20 on the VOM/CAP board.
3	Remove the VOM/CAP board and cable.
4	Gently slide the replacement board and cable into the CTS at long option slot #1 until the edge connector firmly seats.
5	Connect the cable to connector J20 on the 4Z I/O board.

6.3.5 Call Progress and Signaling (Option .35A or .35C) Replacement

Call Progress and Signaling (Option .35A or .35C) consists of a long option board (3735A-1-101 or 3735C-1010-01) and a short option board (3735A-2-101). Instructions for replacing both boards are provided in the following paragraphs.

6.3.5.1 Short Option Board

To remove the short option board (3735A-2-101), proceed as follows:

NOTE: The Call Progress and Signaling short option board may be piggyback-mounted to a second short option board.

STEP	REPLACING SHORT OPTION BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	Disconnect the cable from connector J12 on the Remote Control board by applying steady and uniform pressure to the pull tab.
2	Gently lift the 3735A-2-101 short option board until connector J27 on the right side of the board is exposed. If piggyback-mounted to a second short option board, gently lift the second board from the CTS to expose connector J27.
3	Disconnect the cable at connector J27 on the short option board.
4	Carefully lift the 3735A-2-101 board until connector J26 is exposed.
5	Disconnect the cable at connector J26 on the short option board.
6	Remove the short option board from the CTS. If piggyback-mounted to a second short option board, separate the two.
7	Connect cables to connectors J26 and J27 on the replacement board. If piggyback-mounted, first mount the 3735A-2-101 board to the second short option board.
8	Gently slide the replacement board into the CTS at short option slot #2 until the edge connector firmly seats.
9	Connect the cable to connector J12 on the Remote Control board.

6.3.5.2 Long Option Board

To remove the long option board (3735A-1-101 or 3735C-1010-01), proceed as follows:

STEP	REPLACING LONG OPTION BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	Disconnect the cable from connector J27 on the Call Progress and Signaling board by applying steady and uniform pressure to the pull tab.
2	Gently lift the Call Progress and Signaling long option board and cable from the CTS.
3	Gently slide the replacement board and cable in the CTS at long opton slot #5 until the edge connector firmly seats.
4	Connect the cable to connector J27 on the short option board.

6.3.6 ESF PCM Board (Option .64) Replacement

To remove the ESF PCM board, proceed as follows:

STEP	REPLACING ESF PCM BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	Unplug cables to connectors J4W and J4E on the ESF PCM board. (These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel.)
2	Using two screwdrivers, gently pry up on the notches found at the side of the board until the connected cable at connector J5 is exposed.
3	Disconnect the cable to connector J5.
4	Carefully remove the ESF PCM board.
5	Gently slide the replacement ESF PCM into the CTS at long option slot #7 until the edge connector firm seats.
6	Connect cables to connectors J4W and J4E on the ESF PCM board.

6.3.7 Master/Slave Board (Option .41) Replacement

To remove the Master/Slave board, proceed as follows:

STEP	REPLACING MASTER/SLAVE BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	Disconnect the cable to connector J12 on the Remote Control board by applying steady and uniform pressure to the pull tab.
2	Disconnect the cables to connectors J4W and J4E on the ESF PCM board. (These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel.)
3	Disconnect the cable from the Master/Slave board to connector J23 on the Remote Control board.
4	Using a screwdriver, gently pry up on the notch found at the right side of the Master/Slave board.
5	Carefully remove the Master/Slave board and cable from the CTS.
6	Gently install the replacement Master/Slave board into the CTS at short option slot #1 until the edge connector firmly seats.
7	Connect cables to connectors J23, J4W, J4E, and J12

6.3.8 X-Y Outputs Board (Option .07)
Replacement

To remove the X-Y Outputs board, proceed as follows:

STEP	REPLACING X-Y OUTPUTS BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	Disconnect the cable at connector J29 on the X-Y Outputs board.
2	Disconnect cables to connectors J4W and J4E on the ESF PCM board. (These cables connect to the ESF FACILITY DATA LINK connectors on the CTS rear panel.)
3	Using a screwdriver, gently pry up on the notch found at the right side of the X-Y Outputs board.
4	Carefully remove the X-Y Outputs board from the CTS.
5	Gently slide the X-Y Outputs board into the CTS at short option slot #2 until the edge connector firmly seats.
6	Connect cables to connectors J4W, J4E, and J29.

6.3.9 T1 Bit Error Ratio Board (Option .65) Replacement

To remove the T1 Bit Error Ratio board, proceed as follows:

STEP	REPLACING T1 BIT ERROR RATIO BOARD
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	Unplug cables from J1, J2, and J3 the T1 BER board. All three cables go to the ESF PCM option board.
2	Using two screwdrivers, gently pry up on the notches found at the side of the board.
3	Carefully remove the T1 BER board.
4	Gently slide the replacement T1 BER board into the CTS at long option slot #4 until the edge connector firmly seats.
5	Connect cables to connectors J1, J2, and J3 on the T1 BER board.

6.4 Packing, Shipping, and Return to Factory

PC boards ship enclosed in a special conductive envelope to protect the circuitry from static electricity. If a conductive envelope is not available, DO NOT wrap the board in an ordinary plastic bag or plastic sheeting. Instead, proceed as follows:

STEP	RETURN PROCEDURES
	CAUTION: Static electricity may damage CMOS ICs mounted on plug-in boards. Handle PC boards by top and side edges only. Do not handle by edge connector.
1	If available, cover the entire edge connector with a conductive shorting bar.
2	Wrap the PC board or module in heavy kraft paper.
3	Insert the item in a double-walled shipping container. Surround it with 2 to 4 inches (5 to 10 cm) of thick shock-absorbing material.
4	Mark the container: FRAGILE - DELICATE ELECTRONIC INSTRUMENT

If returning a board to Hekimian for servicing or repair, enclose the following information:

- Type of repair or service required.
- Model and serial number of the unit from which the module came.
- Serial number of the PC board or module.
- Return address.

Keep a copy of all information for yourself and refer to your copy in any correspondence with Hekimian.

6.5 Warranty Information

LIMITED WARRANTIES - DISCLAIMER OF WARRANTIES

Subject to the provisions hereof, Seller warrants the equipment manufactured by Seller and provided to Buyer pursuant to these Terms (the "Equipment") against any defect in design, materials, and workmanship that materially affects its performance (a "Defect") for a period (the "Warranty Period") of one year from the date of delivery thereof, except that the Warranty Period shall be 90 days with respect to rechargeable batteries. Seller shall, at its option and expense in accordance with the procedures described below, repair or replace ("Service") any Equipment that proves to have a Defect during the Warranty Period. This limited warranty is contingent upon Buyer's notifying Seller in writing within ten days following Buyer's discovery of an alleged Defect, and in no event later than ten days following the Warranty Period. Upon authorization by Seller following Seller's receipt of written notice from Buyer, the Equipment may be returned for Service, prepaid and at the sole cost and expense of Buyer, to the facility designated by Seller in such authorization. If examination of the returned Equipment by or on behalf of Seller discloses that any Service performed is not within the scope of this limited warranty, Seller shall invoice Buyer for the costs of examination and Service and for the cost of return of the Equipment to Buyer, and Buyer shall pay costs within 30 days after receipt of such invoice. If such Service is within the scope of this limited warranty, Seller shall return the Equipment to Buyer at the sole cost and expense of Seller.

The limited warranty set forth herein shall not apply with respect to Defects resulting from neglect; misuse; accident; fire or other hazard; unauthorized alteration, modification or repair, including, without limitation, installation of unauthorized parts; improper testing, handling, storage, operation, interconnection, or installation after installation of the Equipment (provided, however, that minor adjustments by skilled personnel of Buyer following procedures prescribed by Seller will not invalidate such warranty); failure to continually provide a suitable central office operating environment (including any necessary electrical, air conditioning, or humidity systems); or any other cause beyond the range of normal usage of the Equipment (except, in all of the foregoing cases, when caused by Seller). This limited warranty shall terminate upon any sale of the Equipment by Buyer. Service of Equipment, in the manner and for the period of time set forth herein, shall be Buyer's exclusive remedy hereunder and shall constitute fulfillment of all liabilities of Seller to Buyer, whether based on contract, negligence or otherwise with respect to the Equipment delivered to Buyer hereunder. Seller reserves the right to make changes in the design or construction of any of its Equipment at any time without incurring any obligations to make any changes whatever on units previously purchased.

EXCEPT FOR THE LIMITED WARRANTY SPECIFICALLY SET FORTH HEREIN, SELLER NEITHER MAKES, NOR ASSUMES ANY LIABILITY UNDER, ANY WARRANTIES (WHETHER EXPRESSED, IMPLIED, OR STATUTORY) ON OR WITH RESPECT TO THE EQUIPMENT OR ANY COMPONENTS THEREOF, OR ANY SOFTWARE, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED CONDITIONS OR WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Any equipment not manufactured by Seller and any software provided to Buyer pursuant to these Term's is provided by Seller "AS IS": (subject to any equipment warranties which the manufacturer thereof makes available to Buyer).

IN NO EVENT SHALL SELLER BE LIABLE TO BUYER OR ANYONE ELSE FOR SPECIAL, COLLATERAL, EXEMPLARY, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER SUCH DAMAGES OCCUR EITHER PRIOR OR SUBSEQUENT TO, OR ARE ALLEGED AS A RESULT OF, TORTIOUS CONDUCT OR BREACH OF ANY OF THE PROVISIONS OF A CONTRACT, EVEN IF SELLER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL AND REINSTALLATION OF EQUIPMENT OR OTHER ITEMS, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE OR INTERRUPTION OF BUSINESS, OR OTHER ECONOMIC LOSS.

Software Rev. 3725A A/B10.06
PN 3772-02

HKMN 103-377-200
Issue 1, May 1987

Model 3700 Option .72 EasyTest™ Editor/RAM Buffer

User's Manual

Manufactured by

HEKIMIAN LABORATORIES, INC.
9298 Gaither Road
Gaithersburg, Maryland 20877 USA
AN AXEL JOHNSON INC. CO.

Telephone (301) 840-1217
Telex 215080 HEKIM UR
Telecopier (301) 840-0476

Model 3700 Option .72 EasyTest™ Editor/RAM Buffer
Imbedded Software and Documentation
© 1987, Hekimian Laboratories, Inc.
Unpublished -- all rights reserved

PREFACE

This manual is a supplement to the User's Manual that covers your Model 3700-series Communications Test System. This supplement provides information on the EasyTest™ Editor/RAM Buffer (Option .72).

TABLE OF CONTENTS

SECTION		PAGE
SECTION 1 -	INTRODUCTION	1-1
1.1	HARDWARE REQUIREMENTS	1-1
1.2	NOMENCLATURE CONVENTIONS.	1-2
1.3	INVOKING THE EDITOR	1-2
1.4	CURSOR GUIDELINES	1-3
1.5	ERASING PROCEDURES.	1-3
SECTION 2 -	EASYTEST™ EDITOR COMMANDS	2-1
2.1	DELETE.	2-2
2.2	UP AND DOWN	2-2
2.3	SAVE.	2-3
2.4	QUIT.	2-3
2.5	INSERT.	2-3
2.6	LINE.	2-4
2.7	TYPE.	2-4
2.8	GET	2-5
2.9	LIST.	2-5
SECTION 3 -	EASYTEST™ PROGRAMMING STATEMENTS	3-1
3.1	GENERAL STATEMENTS.	3-1
3.2	MESSAGE STATEMENTS.	3-2
3.3	PARAMETER STATEMENTS.	3-7
3.4	WAIT STATEMENTS	3-8
3.5	MISCELLANEOUS STATEMENTS.	3-11

TABLE OF CONTENTS (continued)

SECTION		PAGE
SECTION 4 -	SYNTAX REQUIREMENTS	4-1
SECTION 5 -	EASYTEST™ PROCEDURE FORMAT	5-1
5.1	PROCEDURE NAMES	5-1
5.2	PROCEDURE PARAMETERS.	5-2
5.3	VERIFY OPTION	5-4
SECTION 6 -	PROGRAMMING TECHNIQUES	6-1
6.1	WRITING TEST SEQUENCING EASYTEST™ PROCEDURES.	6-1
6.2	LOOPING	6-2
6.3	SUBROUTINES	6-3
SECTION 7 -	EASYTEST™ PROCEDURE EXAMPLE	7-1

SECTION 1 - INTRODUCTION

This manual is a supplement to the Operator's Manual that covers your Model 3700-series Communications Test System. This supplement provides information on the EasyTest™ Editor (Option .72).

EasyTest™ procedures are programmed routines or "macro" instruction sets that contain procedure language commands. These procedures enable you to perform a complex test procedure by entering one command.

The 3700 EasyTest™ Interpreter (Option .70) is designed to allow the user the opportunity to sequence test set activity. The language creates great flexibility in the way the 3700 can interface with remote users. It is possible to perform alternative testing based on received signal status without remote user intervention, create test sequences, and store test results for delayed interrogation. This allows for more efficient use of controlling computer resources.

1.1 HARDWARE REQUIREMENTS

The Option .25A-232/.25A-488 comes equipped with Option .74 RAM Buffer and has adequate RAM for Option .72 operation. The EasyTest™ Editor is located in an EPROM with the Option .70 EasyTest™ Interpreter located at IC 12 on the Option .25A.

At power-up, the 3700 checks for the presence of the Eprom with the EasyTest™ Editor and if present, enables EasyTest™ Editor entry. The presence of the editor may be determined by the DCAP command which will display ".72 EASYTEST EDITOR" as an installed option.

1.2 NOMENCLATURE CONVENTIONS

An effort has been made to standardize the format descriptions in this section. Angle bracks (<>) enclose keywords used in the procedural language. These keywords are not intended to be taken literally, but rather are descriptors of the keyword used. Examples of all the commands are given later in this manual. Optional elements are enclosed in square brackets ([]). Again, the square brackets are not part of the language; but instead, are used to group the optional parameters.

The directory can be listed with a DIR command showing the size and status along with name of all procedures known to the system. The DIR command will also give the ID number of the EasyTest™ procedure set resident in read only memory (ROM) and the size of the unused portion of the RAM. The EasyTest™ procedure set ID number has the form: .71-XXX where ØØ1 ≤XXX≤ 999. The free RAM area is the maximum size PROC that can be created in the editor. (Free RAM is also the area where data is stored when the 3700 is commanded to do so.)

1.3 INVOKING THE EDITOR

The EDIT command is used to invoke the EasyTest™ Editor. If any of the hardware or firmware requirements of the editor are not installed, the 3700 will send the message "E06 MOD ABST". The command has the form:

EDIT <procname>

where the procedure name is any valid procedure name (see Procedure Names). When the 3700 receives a valid Edit command, it searches the directory to find the named procedure. If it is found, the procedure is copied into the Editor's workspace and the first line is displayed with the line number 1. If the procedure name is new, the 3700 prints "NEW FILE" and automatically inserts an END statement.

The 3700 indicates that it is in the editor by changing the prompt characters to read "E>".

1.4 CURSOR GUIDELINES

The cursor points to a location within the editor's work space. It will always be pointing to the beginning of a line and all editing commands occur relative to its position. Any insertions into a procedure being edited will occur immediately before the line pointed to by the cursor, and all deletions will occur starting with the line pointed to by the cursor.

1.5 ERASING PROCEDURES

Procedures may be deleted providing they exist in RAM. This is done with an ERASE command. If a procedure in RAM superceding a procedure in ROM is erased, the procedure in ROM will be reenabled. When a procedure is deleted, the remaining procedures in memory are compacted to preserve space. The command has the form:

ERASE <procname>

SECTION 2 - EASYTEST™ EDITOR COMMANDS

The following list contains the commands which may be used in the Option .72 EasyTest™ Editor to edit a procedure:

DEL(ete)
DIR(ectory)
D(own)
GET
I(nsert)
INSERT
L(ine)
LINE
LIST
QUIT
T(ype)
TYPE
SAVE
U(p)

This section will describe the syntax and function of these commands with the exception of the DIR command which has already been covered. While in the Line Editor, the 3700 HELP command will provide a list of the valid editor commands.

2.1 DELETE

The DELete command is used to remove lines from the work space. The user may specify the number of lines to be deleted; however, if this parameter is omitted, a single line will be removed. Deletion takes place starting with the current line and continuing for the specified number of lines. If a number larger than the number of lines remaining in the work space is specified, all lines from the current line thru the end of the work space will be deleted except for the END statement. This statement has the form:

DEL <number of lines>

where the number of lines may take any value from 0-999.

2.2 UP AND DOWN

The Up and Down commands are used to move about within the work space. They move the cursor 1 line for each time they are used. If the cursor is already at an end of the current work space, any command for further movement will be ignored. These statements have the form:

D
U

2.3 SAVE

The SAVE command is used to exit the line editor and store the contents of the work space as a procedure with the name specified in the EDIT command. If the procedure is a new one, it is given a new directory entry and the line editor session is ended. If the procedure updates a procedure contained in ROM, a new directory entry is created with the same name, and the procedure in ROM is flagged as having been superceded. A PROC command invoking that name will execute the procedure in RAM; however, if the procedure is erased, the procedure in ROM will be reenabled. If a procedure updates an existing procedure in RAM, the previous procedure will be automatically erased during the saving process. (Note: To save the RAM procedure, edit a new procedure and copy the old procedure into it with a GET command.) This command has the form:

SAVE

2.4 QUIT

The QUIT command ends the editor session without storing the work space or updating the directory. It has the form:

QUIT

2.5 INSERT

The INSERT command causes all following input characters to be stored as received in the editor work space. The characters are stored immediately preceding the current line and no distinction is made between printable and control characters. Two consecutive carriage returns will exit from the Insert mode and restore the editor prompt. This command has the forms:

INSERT or I

2.6 LINE

The LINE command is used to position the cursor within the editor work space. This command sets the cursor to the line number indicated in the command. If the line number specified is greater than the total number of lines in the procedure, the cursor will be placed at the last line in the procedure. This command has the forms:

```
LINE <line number>
L <line number>
```

where line number may take any value from 1 - 999.

2.7 TYPE

The TYPE command lists the specified number of lines with their line numbers beginning with the current line. If a number greater than the number of lines from the current line to the end of the procedure is specified, this command will type out the remaining lines and display the message "END OF FILE". If no number of lines is specified, the editor will type one line. This command has the forms:

```
TYPE <number of lines>
T <number of lines>
```

where number of lines may take any value from 0 - 999.

2.8 GET

The GET command loads an entire procedure into the editor's work space, inserting it before the current line. Caution should be used when using the GET command as it also transfers the end statement, which then must be deleted from the procedure being edited. This command has the form:

GET <procname>

where procname refers to any already existing procedure.

2.9 LIST

The list command is used to view the contents of a procedure (not the one in the work space) while not aborting an edit session. This command may also be used outside the editor to read the text of a procedure. This command has the form:

LIST <procname>

where procname refers to any already existing procedure.

SECTION 3 - EASYTEST™ PROGRAMMING STATEMENTS

All current Option .25 or .25A commands are valid procedural language statements in their present format. They are the means by which 3700 test functions are invoked. For a list of these commands and their formats see the Option .25 or .25A commands. The EasyTest™ statements create a framework upon which test sequences are created and executed. The following are the EasyTest™ statements:

AMSG	IF
CLEAR	INC
DEC	LABEL
ELSE	MSG
END	PROC
ENDIF	SET
EXIT	STOP
GOTO	WAIT

3.1 GENERAL STATEMENTS

PROC

One procedure may "call another", nesting up to ten levels deep. If a PROC tries to go deeper than ten levels, the procedure will be halted and an error message displayed. (See Invoking a Procedure in Section 5.1 for the statement form.)

END

The END statement must be the last statement in a procedure and terminates its execution. If an END statement is encountered in a called procedure, control reverts to the original procedure's statement immediately following the calling PROC statement.

Form:
END

EXIT

The EXIT statement may occur anywhere within a procedure except as the last statement. This statement acts functionally like an END statement.

Form: EXIT

STOP

This statement terminates procedure operation from any level of nesting.

Form: STOP

3.2 MESSAGE STATEMENTS

A message statement is used for generating information or error statements. They cause the displaying of the indicated test.

MSG

The MSG statement generates a message on a new display line.

Form: MSG <Text of message>

AMSG

The AMSG statement appends the message to the currently displayed line.

Form: AMSG <Text of Message>

LABEL

The 3700 EasyTest™ Interpreter allows for the setting of up to 10 LABELS used to divert procedure execution flow. A LABEL statement must be executed to define its address. LABELS are designated 0 through 9. LABEL addresses are stored independently of the procedure being executed, and are redefined only by the execution of a subsequent LABEL statement using the same LABEL number. At power-up, all LABELS are undefined.

Form: LABEL <label number>

GOTO

This statement diverts procedure flow to the statement following a previously executed LABEL statement. Returns "ERR 1 - LABEL UNDEFINED" if LABEL has not been previously encountered.

GOTOs across nesting levels are not disallowed, but are considered poor programming practice.

Form: GOTO <label number>

IF, ELSE Statements

The use of IF statements allows conditional processing within procedures. IF statements may be nested up to 255 levels. When an IF statement is encountered, it is evaluated as true or false. Statements are executed following a true condition and ignored following a false condition until an ENDIF statement is encountered. An ELSE statement reverses the above statement. IF sequences need not be followed by an ELSE statement; however, an IF statement must precede an ELSE.

Form: ELSE

IF TIMEOUT

This condition can be used after certain WAIT statements and is true if the specified timeout period was exceeded. The timeout flag is set conditionally by the WAIT LEVEL and WAIT FREQUENCY statements.

Form: IF TIMEOUT

IF NO TIMEOUT

Opposite of the previous statement.

Form: IF NO TIMEOUT

IF PARAMETER

This command returns true if the referenced parameter has been defined. Any user-definable parameter may be tested. These parameters are P1 - P6, L1 - L3, and COUNT.

Form: IF P2

IF PARAMETER EQUAL TO INTEGER

This tests the value of a variable and returns true if the variable contains the specified value. Any of the Global or Local parameters may be tested along with a variable called COUNT. The variables are referenced P1 thru P6, L1 thru L3, and COUNT. The comparison value may range from 0 to 9999. Using this construct allows the use of any variable as a counter and enables 2 variables to be compared to each other.

Form: IF COUNT = <value> or IF P1 = <value>

IF PARAMETER EQUAL TO STRING

This tests the value of the parameter specified and returns true if the parameter is an exact match of the specified string. In the string specification an "X" is a don't care character and will match any character at that location. The string "" is the null string and returns true only if the parameter to be tested has not been defined.

Form: IF P1 = "string"

One can also compare two parameter values by using this IF statement.

Form: IF P1 = *P2

IF SLAVE

This statement evaluates true if the unit running the procedure is a slave under Option .41 Master/Slave operation.

Form: IF SLAVE

IF TIMER

This statement evaluates true when an integrating measurement is in progress.

Form: IF TIMER

IF CHANGE

This statement looks for a change in a 3700 receive signal frequency and evaluates true IF the change is greater than or equal to the specified increment. A true condition causes the new value to be stored for subsequent change testing. This command works when the 3700 is measuring level, noise, impulse noise, hits/dropouts, jitter or envelope delay. When not measuring one of these, the test results are unpredictable.

Form: IF CHANGE <Increment>

where increment is xx.xxkHz

IF CLOCK

This statement checks a continuous system clock for an elapsed time equal to or greater than the specified number of seconds. It returns true if the indicated time has elapsed. This statement enables the creation of synchronized PROCs. This clock may assume a value from 0 to 9999 seconds (>2.75 hours). When starting a synchronous test, the clock should be reset with a CLEAR CLOCK command.

Form: IF CLOCK <time value>

where time value is xxxxSEC

IF FUNCTION

The IF FUNCTION statement accepts any 3700 opcode and an ASCII string as parameters and examines the results of the opcode for the specified string. It evaluates true if the string is a subset of the results of the test. An "X" within a string maintains a position within the string, but matches any character.

Form: IF (<op code>) = "string"

As an example the statement: IF (MLVL) = "0.XDBM" will evaluate true for the following level ranges: +10.0DBM, +0.9DBM thru -0.9DBM, -10.0DBM thru -10.9DBM, -20.0DBM thru -20.9DBM, -30.0DBM thru -30.9DBM, etc.

IF KEY

The IF KEY statement compares the last character received by the 3700 with the character specified in the command. This allows the user to interact with a procedure while it is running. (i.e. Menu driven procs)

Form: IF KEY = "<character>"

ENDIF

This statement terminates an IF block. An ENDIF statement must be present for each IF statement.

Form:
ENDIF

3.3 PARAMETER STATEMENTS

Parameters are provided for loop control and condition passing as well as passing of text messages. When used for numbers, parameters may assume a value of 0 to 9999 and their value may be tested with the IF PARAMETER series of statements. The value of all (except for the 3 local) PARAMETERS are maintained outside of the procedure and retain their value unless redefined. This allows for their use as a passable variables.

SET PARAMETER

This statement causes the specified value to be stored in the appropriate PARAMETER variable.

Form: SET P1 =<new PARAMETER value>

where the new value may be numbered from 0 to 9999 or an ASCII string enclosed in double quote marks

DEC PARAMETER

This statement causes the value stored in PARAMETER to be decremented. If the value was already zero, the statement has no effect. If the parameter does not contain a numeric variable, the DEC statement return the message "ERR 3 - TYPE ERROR".

Form: DEC COUNT

INC PARAMETER

This statement causes the value stored in PARAMETER to be incremented. If the value was 9999, the statement has no effect. As in the DEC command, a nonnumeric variable will return an error message.

Form: INC P1

3.4 WAIT STATEMENTS

The 3700 procedure language allows procedural execution to wait for the occurrence of various events before proceeding. Any event which may never occur has a selectable timeout period associated with it. If no time is given, the time is set as zero and a timeout occurs if the condition being waited for is not currently present. Times may assume the range 0 to 99.9SEC in tenths of seconds.

WAIT TIME

This statement is a timing WAIT and suspends execution for the specified interval. Allowed intervals are from 0 to 99.9 SEC, and an omitted time is assumed to be zero. This command does not affect timeout validity for IF TIMEOUT statement.

Form: WAIT TIME=<time to wait>SEC
WAIT T=<time to wait>SEC

where time to wait is in the form of xx.x

WAIT TIMER

WAIT TIMER causes execution to be suspended until the 3700 integrating measure timer stops. There is no timeout associated with this WAIT and if one is specified, it will be ignored.

Form: WAIT TIMER

WAIT LEVEL

This statement tests for a receive level between the specified ranges. If either the high or low range is omitted, the specified limits of the 3700 are inserted (+10.0 to -70.0dBm). The statement causes suspension of the procedure until a level between the two limits is read, or until the specified time elapses. For accurate results, the 3700 must be set to a function were level measurements are being made.

Form: WAIT LEVEL=<low limit>DBML <high limit>DBMH
T=<timeout>SEC
WAIT L=<low limit>DBML <high limit>DBMH
TIME=<timeout>SEC

where <low limit> and <high limit> are in the form +/-xx.x and the <timeout> is in the form xx.x

WAIT FREQUENCY

This statement works the same way as the previous statement, using the receive frequency as the test condition. The high and low ranges for frequency are 0.04 kHz on the low side and either 4.00 kHz or 20.01 kHz for a high limit depending on the presence of Option .09. The resolution of this test is 10 Hz. This statement will only work properly in a function that is measuring frequency.

Form: WAIT FREQ=<low limit>LL <high limit>HL
T=<timeout>SEC
WAIT F=<low limit>LL <high limit>HL
TIME=<timeout>SEC

where <low limit>, and <high limit> are in the form xx.xx and the <timeout> is in the form xx.x

WAIT SLAVE

This statement is used to coordinate Master/Slave procedures where independent PROC's are being run in each unit. This statement holds up the execution of PROC statements by the master until the slave has completed its procedure.

Form: WAIT SLAVE

3.5 MISCELLANEOUS STATEMENTS

CLEAR CLOCK

This statement sets the system clock to 0 elapsed time.

Form: CLEAR CLOCK

INC FREQUENCY

This statement increments the send frequency by the specified amount. If the frequency is at the upper limit, or less than the incremental amount from it, the send frequency is set to the upper limit. If no increment is specified, the default of 100 Hz is used.

Form: INC FREQ XX.XXKHZ

SECTION 4 - SYNTAX REQUIREMENTS

The 3700 accepts one or more spaces, a comma with or without blanks either before or after, and in some cases an "=" sign as parameter or field separators. When an "=" sign is allowed, it is designated "=" and may be omitted.

When a numeric parameter is given units, they must be entered as shown immediately following the final digit. If a sign is specified, the variable will be assumed to be positive if none is entered. If the specified format is xx.xSEC, then "xx.SEC", "x.SEC", "xSEC", ".xSEC", and "x.xSEC" are acceptable entry formats. The following are not acceptable:

xS -- Incorrectly specified units

xxxSEC -- Too many digits to the left of the decimal point

.xxSEC -- Too many digits to the right of the decimal point

xx.x SEC -- Space between digits and units is not allowed

SECTION 5 - EASYTEST™ PROCEDURE FORMAT

A procedure (PROC) contains 1 or more statements from the procedural language or the 3700 test command set. The last statement in a procedure is the END statement. Each statement in a PROC must be on a separate line and be terminated with a carriage return.

As more than 1 space is ignored on command lines, spaces are used in the examples given to enhance readibility by indicating the PROC's structure.

5.1 PROCEDURE NAMES

A PROC name contains from 1 to 8 characters from the printable ASCII character set. Caution should be taken if using '*P1' - '*P6' or '*L1' - '*L3' in a name statement, as these sequences are the parameter substitution designators. (See Section on procedure PARAMETERS)

Invoking A Procedure

A PROC is executed by sending to the 3700 a PROC statement. This statement has the form:

```
PROC <procname> [V] [^GLOBAL1;...GLOBAL6][~LOCAL1;...
LOCAL3]
```

where any number of blanks may occur between the statement identifier "PROC", the PROC name and the parameter start character, or " ", but any blank within the parameter field will be treated as part of the parameter. A semicolon between parameters is mandatory, but may or may not be included after the last one. If it is not necessary to specify any parameters, this field may be omitted.

Upon receipt of a PROC statement the 3700 will search for the designated procedure and, if found, will start its execution. If the specified procedure does not exist, the message "E01 INV CMND" will be returned.

Aborting a Procedure

To abort a procedure in progress, send a CTRL-A (ASCII 01). This will interrupt the procedure and return a prompt. Note that data buffering may have been left active, and it may be necessary to perform an SBUF OFF DUMP command to restore normal operation.

5.2 PROCEDURE PARAMETERS

When a procedure is invoked, it may be passed up to six global and three local parameters. These parameters may be from 0 (NULL STRING) to 20 characters long and contain any character except ";". These parameters are stored as text strings, and the global parameters are altered only by powering down the 3700 or by redefining the parameter. The list of global parameters is always preceded by ^ (ASCII 5E) and the list of local parameters is always preceded by ~ (ASCII 7E).

Parameters are position dependent within the entry string and are stored and referenced in the order they are entered. If only the 3rd global parameter is to be specified, the entry must read "^;;<global 3>" where the semicolons are used to indicate unused parameters. In this case, the first two parameters would be set equal to the null string. If it is

desired to change the 3rd parameter without altering the first two, the entry should read "^*P1;*P2;<Global 3>". Parameters may also be swapped when invoked by inserting one designator string into another position ("^*P2;*P1"). The parameters are referenced by the character sequences *P1 through *P6 for global parameters and *L1 through *L3 for the local variables. Use of one of these sequences in a command line causes the sequence to be replaced by the referenced parameter. At power-up, all parameters equal null strings.

Global parameters will maintain the same value for all subroutines which may be invoked by the highest level procedure, while local variables are known only to the presently executing procedure. Local variables are stored and restored as a procedure invokes and returns from sub-procedures; however, any unspecified local parameters will have the null string value in any procedure level.

Parameters may be used to hold text strings or numeric variables. If numbers are used, they may be in the range of 0 - 9999.

As an illustration of the use of parameters, consider the following PROC's:

TEST defined as:

```
MSG TEST DATE: *L1
SSND *P1 *P2
PROC LEVEL ~.4KHZ
PROC LEVEL ~1.0KHZ
PROC LEVEL ~2.8KHZ
MSG TEST COMPLETED *L1
END
```

and LEVEL defined as:

```
SSND *L1
WAIT T=*P3SEC
MLVL
END
```

If the procedure "TEST" were invoked as follows:

```
PROC TEST ^0DBM;1KHZ;3 ~10/8/84
```

it would print the message "TEST DATE: 10/8/84", set the generator to send 1 kHz at 0dBm, call the subprocedure "LEVEL" 3 times, and finally display the message "TEST COMPLETED 10/8/84". Each time the procedure "LEVEL" was called, it would set a new send frequency, wait 3 sec, and then take a level measurement.

5.3 VERIFY OPTION

When a procedure is being executed, no output except the actual test data is sent to the user. In order to assist in the creation and debugging of user-written procedures, the VERIFY option may be specified in the PROC command string. When the VERIFY option is specified, the 3700 will print each command immediately before executing it. The VERIFY option is invoked by including the parameter "V" on the PROC invocation command line.

NOTE: If this option is specified after the Global or Local parameter character, the semicolons designating unused positions must be included. The VERIFY option has the form:

```
PROC <procname> V ^GLOBAL 1[;...GLOBAL 6] ~LOCAL
1[;...LOCAL 3]
```

The command lines are preceded by an asterisk to differentiate them from normal procedure output.

SECTION 6 - PROGRAMMING TECHNIQUES

This section uses sample procedures to illustrate possible uses of the procedure language. All uses and cases are not covered due to space limitations; however, most general programming structures will be illustrated.

6.1 WRITING TEST SEQUENCING EASYTEST™ PROCEDURES

The simplest use of the procedural language is as a test sequencer. The following procedure will measure impulse noise, hits, and drop outs for an operator selectable interval, displaying the current counts on an input interval. When the integrating measure is over, it measures phase jitter, noise, level and frequency. The following command would be used to invoke this procedure:

PROC TEST1 Λ5;1.0 where TEST1 is the following procedure:

```
MIHD *P1MIN *P2INT
MPHJ
MNSE
MLVL
END
```

The first parameter controls the length of the integrating measure, and the second parameter determines the interval on which intermediate results are returned.

The parameters passed with the PROC command are stored as text strings and will be inserted into the MIHD command string as earlier explained. This PROC will cause the 3700 to execute the given sequence of commands before it returns control to the remote user. (Receipt of a prompt (->) indicates user control.)

6.2 LOOPING

The LABEL, GOTO and IF statements allow the programming of loops. The following procedure demonstrates a section of a procedure which measures the level and frequency every five seconds for a parameter selected number of times. When the selected number of repetitions are finished, the message "LEVEL LOOP FINISHED" will be displayed and execution will proceed to the statement following the ENDIF.

```
SET COUNT=*P1      Count set to parameter value
LABEL 0
WAIT T=5SEC
MLVL
DEC COUNT
IF COUNT=0
MSG LEVEL LOOP FINISHED
ELSE
GOTO 0
ENDIF
```

Looping can also be done while waiting for a condition to occur. The next section of PROC language code waits for one minute or a valid level before continuing.

```
SET COUNT=12
LABEL 2
WAIT LEVEL T=5SEC
IF TIMEOUT
    DEC COUNT
    IF COUNT=0
        MSG INVALID LEVEL
    ELSE
        GOTO 2
    ENDIF
ELSE
    MSG LEVEL IN RANGE
ENDIF
```

NOTE: By not specifying any level range, the range -70dBm to +10dBm is used.

6.3 SUBROUTINES

Any procedure may be used as a subroutine by executing a PROC statement within a procedure. It is a good practice to put commonly used blocks of code into a separate procedure as this saves memory space. The following procedure makes use of the previously defined TEST1 procedure. It performs the same measurement sequence an operator-selected number of times, but only displays the hits/dropout counters once in a cycle. This procedure would be invoked:

```
PROC TEST2 ^5,12
```

where the 1st parameter is the length of time for the integrating measure test and the 2nd is the number of repetitions.

```
SET COUNT=*P2          set COUNT to number of
                       repetitions
LABEL 0                set looping entry point
PROC TEST1 ^*P1;*P1
DEC COUNT
IF COUNT=0
EXIT
ENDIF
GOTO 0
END
```

NOTE: Parameter 2 set to parameter 1, the print interval in PROC TEST1 will equal the test length.

When PROC TEST1 reaches its END statement, control will go to the DEC COUNT statement immediately after the PROC statement.

SECTION 7 - EASYTEST™ PROCEDURE EXAMPLE

NOTE: In the example PROC, comments are made in the right margin. These are not to be entered into the 3700 PROCs. These comments are used for example only.

This procedure is included as an example of possible uses of procedure. It monitors the receive frequency and causes the level and frequency to be measured whenever the frequency changes by more than 50 Hz. If the frequency does not change by 50 Hz in 10 seconds or does not stabilize for 0.5 seconds, an error message is displayed. This procedure calls a procedure which checks for a 50 Hz frequency change. The called procedure in turn calls a procedure which checks for a stabilized reading. The first procedure has no parameters and is invoked:

```
PROC RXFSWP
```

where RXFSWP is defined:

```
SLVL                Enable frequency detection
LABEL 1
PROC FCHNGE         Subroutine called
IF COUNT=0          Count variable is used to pass
MLVL                status from subroutine to
                    caller.
```

```
ELSE
MSG NO VALID READING IN 10 SECONDS
ENDIF
GOTO 1
END
```

NOTE: Operator terminates this procedure.

```
PROC FCHNGE
```

where FCHNGE is defined:

```
     SET COUNT=15     Count to control loop
     LABEL 9
     IF COUNT=0       If at end of wait period
     SET COUNT=1      count is used to pass
     EXIT             status to caller.
     ENDIF

       IF CHANGE .05KHZ
         PROC SETTLE
     stabilized reading.
          IF COUNT=0
             EXIT
             ELSE
          DEC COUNT
          DEC COUNT
            GOTO 9
            ENDIF
             ELSE
         WAIT T=.3SEC
          DEC COUNT
            ENDIF
            GOTO 9
             END
```

```
PROC SETTLE
```

where SETTLE is defined:

```
        WAIT T=.5SEC
      IF CHANGE .01KHZ
        WAIT T=.5SEC
      IF CHANGE .01KHZ
        WAIT T=.5SEC
      IF CHANGE .01KHZ
           EXIT
           ELSE
        SET COUNT=0
           EXIT
          ENDIF
           ELSE
        SET COUNT=0
           EXIT
          ENDIF
           END
```

GLOSSARY

Acronyms or Abbreviations

2W	Two-wire circuit.
4W	Four-wire circuit.
AIS	Alarm Indication Signal.
AMI	Alternate Mark Inversion.
ASC	Abnormal Station Condition.
ASCII	American Standard Code for Information Interchange.
AutoREACT	Hekimian's Automated Remote Access and Test System.
B8ZS	Bipolar Eight Zero Substitution.
Bellcore	Bell Communications Research, Inc.
BER	Bit Error Rate.
BERR	Bit Error Rate.
BERT	Bit Error Rate Test.
bit	Binary digit.
BOC	Bell Operating Company.
BPNRZ	Bipolar Non-Return-to-Zero.
BPRZ	Bipolar Return-to-Zero.
bps	Bits per second.
BPV	Bipolar Violation.
CAC	Customer Access Code.
CCS	Common Channel Signaling.
CLCI	Common Language Circuit Identification codes.
CLFI	Common Language Facility Identification codes.
CLLI	Common Language Location Identification codes.
CMI	Control Mode Idle.
CO	Central Office.
CPU	Central Processing Unit.
CRC	Cyclic Redundancy Check.
CSU	Channel Service Unit, Customer Service Unit, or Channel Loopback code.
CTC	Centralized Test Center.
CTS	Communications Test System.
DATS	Digital-Analog Test System.
dBm	Decibel (dB) referred to 1 milliwatt.
dBrn	Decibels above reference noise.
DCE	Data Circuit-Terminating Equipment.
DCS	Digital Cross-Connect System.
DDS	Digital Data System or Digital Data Service.
DEC	Digital Equipment Corporation.
digroup	Digital group.
DLC	Digital Loop Carrier.
DPU	Hekimian Model 6301 DS-1 Performance Unit.
DS-1	Digital signal at level 1.
DSA	Digital Serving Area.
DSAU	DS-1 Signal Access Unit.
DSU	Data Service Unit.
DSX	Digital System Cross-Connect.

DTAS	Digital Test Access System.
DTAU	DS-1 Test Access Unit.
DTAU+	DS-1 Test Access Unit Plus.
DTE	Data Terminal Equipment.
DTMF	Dual-tone multifrequency.
DTU	Hekimian Model 6302 DDS Test Unit.
EC	Error correction.
EFS	Error Free Second.
EIA	Electronic Industries Association.
EM+	Enhanced Monitor Plus.
EM/MU	Enhanced Monitor/Matrix Unit.
ERRSEC	Errored Seconds.
ESF	Extended superframe.
FAD	Facility Access Digroup.
FBE	Framing Bit Error.
FDL	Facility Data Link.
FDM	Frequency Division Multiplexing.
FEV	Far-End Voice.
FPS	Framing Pattern Sequence.
FRMBE	Framing Bit Errors.
Fs	Signaling Framing.
F_t	Terminal Framing.
HCDS	High Capacity Digital Services.
HSC	Hierarchical Storage Controller.
IEC	Inter Exchange Carrier.
IPR	Inside Plant Repeater.
kbps	Kilobits (10^3) per second.
KSR	Keyboard send/receive.
LATA	Local Access and Transport Area.
LATS	Loop Access Test System.
LBE	LoopBack Enable.
LIU	Line Interface Unit.
LOS	Loss of Signal.
LRC	Longitudinal Redundancy Check.
LSA	Local Serving Area.
LSC	Loopback Select Code.
M/MU	Monitor/Matrix Unit.
MA	MJU Alert.
MAP	Minimum Acceptable Performance.
Mbps	Megabits (10^6) per second.
MF	Multifrequency.
MJU	Multipoint Junction Unit.
MOS	MUX Out of Sync.
MTAU	Metallic Test Access Unit.
MUX	Multiplex.
OCU	Office Channel Unit.
opcode	Operation code.
OPR	Outside Plant Repeater.
PAD	Packet Assembler/Disassembler.
PCM	Pulse Code Modulation.
PCO	Plant Control Office.
PID	Process IDentification.

POP	Point of Presence.
PPSN	Public Packet Switched Network.
proc	Procedure.
PSDS	Public Switched Digital Service.
QRSS	Quasi-Random Signal State.
RAM	Random Access Memory.
RAU	Hekimian Model 3204 Relay Access Unit.
REACT	Hekimian's Remote Access and Test System.
ROM	Read-Only Memory.
RRO	Responsible Repair Organization.
SERRSEC	Severely Errored Seconds.
SES	Severely Errored Seconds.
SF	Superframed or single-frequency.
SLC-96™	Subscriber Loop Carrier 96-channel system by AT&T.
SLU	Spare Line Unit.
SMAS	AT&T Switched Maintenance Access System.
SRDC	Subrate Digital Cross-connect.
SRDM	Subrate Digital Multiplexer.
SYS	SYStem GENeration.
T1DM	T1 Data Multiplexer.
TA	Test Alert.
TAD	Test Access Digroup.
TAS	Hekimian Model 3200 Test Access System.
TDM	Time Division Multiplexing.
TEIU	Test Equipment Interface Unit.
TIP	Transition In Progress.
TLP	transmission level point.
UF	Unframed.
UMC	Unassigned MUX Channel.
USTA	United States Telephone Association.
VAX	Virtual Address eXtension.
VDT	Video display terminal.
VF	Voice frequency.
VMS	Virtual Memory System.
YEL	Yellow alarm or remote alarm.
ZBTSI	Zero-Byte Time Slot Interchange.

Definitions

A and Z direction. For a two-point circuit, one end is A and the other end is Z. For a multipoint circuit, the master station is A and the remote stations or terminals are Z.

Abnormal Station Code. Network control code S0011110.

Alarm Indication Signal. An unframed All 1s signal.

All 1s code. There are 15,360 or less zeroes received in one second. When a device looses synchronization, it sends an All 1s code to keep the network up. It also sends this code to tell the tester there is a transmission problem.

Alternate Mark Inversion. A pseudo-ternary signal that conveys binary digits. In this signal successive marks normally alternate between positive and negative polarity. The marks are equal in amplitude. A space designates zero amplitude. Another term for this is bipolar signal.

American Standard Code for Information Interchange. A code with seven information signals plus one parity check signal. Is useful for interworking between computers.

analog signal. A nominally continuous electrical signal that varies in amplitude or frequency.

asynchronous error measurement. A measurement that detects error events referenced by the system's time clock.

autoframe. Determines the framing on the line and reports the framing format.

backup. To copy a disk for safe keeping.

bandpass filter. A circuit designed to allow only frequencies within a specific range to pass. The cutoff frequencies must be finite and nonzero. The band of frequencies between the cutoff frequencies is the passband.

baseband. A digital stream that carries one information channel.

baud. A unit of transmission speed. It represents the number of discrete signaling elements transmitted in one second.

binary digit. The smallest piece of digital information possible.

bipolar coding. A T-carrier line coding system. This system inverts the polarity of alternate 1's bits.

Bipolar Eight Zero Substitution. A line-coding format for T1 lines that uses BPVs to encode strings of eight consecutive zeroes. This coding format makes sure that the minimum pulse-density requirements are met without pulse-stuffing. This is true even for long strings of data zeroes.

Bipolar Return-to-Zero. A 3-level code in which alternate 1s change in sign. (For example, 1011 becomes +1, 0, -1, +1.) Also, transitions between adjacent 1s pause at the zero voltage level.

bipolar violation ratio. The number of accumulated BPVs in the last monitored interval divided by the number of bits in that interval. Any one second where there is an LOS condition is not included in this computation.

bipolar violation. The bit stream contains a pulse of the same polarity as the previous pulse and which is not part of a B8ZS code.

bipolar. A 2-state code where successive "1" signals alternate between positive and negative polarity.

bit error count. The total number of bit errors counted during a timed test.

bit error rate. The number of bit errors in a given group of bits or the ratio of errored bits to transmitted bits. Is usually expressed as a power of 10. Orders of 10^{-6} or greater are the goal in digital transmission, while 10^{-4} are marginally acceptable for voice transmissions. (This does not include frame bits, CRC-6 bits, and data link bits.)

bit error. The bit received in the data pattern is different from the one expected. This means the value of an encoded bit has changed during transmission. When this happens, the receiving end interprets the bit incorrectly.

bit robbing. The technique used to allow the digital data in the DS-1 stream to carry the signaling supervision. The least significant bit per channel in every sixth frame carries the signaling.

bit stuffing. The process of adding extra bits to the incoming customer data. These bits permit synchronization and signaling.

block error. One or more bits in a 1-second window are in error.

boot. To start the computer from power off.

bootstrap. The process of starting a computer from power off.

BPV code. A specific BPV sequence purposely introduced to the local loop for network control.

BPV count. The total number of BPVs counted during a timed test interval.

BPV rate. The rate of erroneous received data bits to total received data bits. This excludes framing bits, CRC-6 bits, or data link bits. (For example, 192 out of 193 per frame.)

bridging connection. A parallel connection that draws some of the signal energy from a circuit, often with inconsequential effect on the circuit's operation.

byte stuffing. The technique which increases the speed of a digital stream by repeating bytes and transmitting them at a faster rate. This does not increase the information content of the stream.

byte. A group of 8 consecutive binary digits associated with a single user.

Central Office. Usually a local switching system. In more general terms, any network switching system. Sometimes means a telephone company building which houses a switching system. Can also mean equipment (such as transmission system equipment) that such a building may contain.

Central Processing Unit. The main frame or heart of the computer.

Channel Loopback. Network control code S0101000.

Channel Service Unit. A unit located on the customer's site that terminates a channel. Used with the customer's logic and timing recovery circuitry.

channel. A transmission path between two points. May refer to a one-way path. When paths in the two directions of transmission are always associated, refers to a two-way path. This is usually the smallest subdivision of a transmission system by which a single type of communications service (i.e., voice or data) is provided. In channelized testing, a channel is a single 64-kbps signal.

checksum. The total group of data items.

circuit. A communications path between two or more points. See channel.

collection hub. Collects data from a number of end offices. Then combines data into a single bit stream for transmission back to the hub office. It does not have test capability, MJUs, or analog extension equipment.

Common Channel Signaling. A signaling method where a single channel conveys, by labeled messages, signaling information. This information relates to several circuits and is useful for network management.

Communications Test System. The Hekimian Model 3700-series test equipment. This equipment is for analog and channelized testing.

Control Mode Idle. See Idle code.

control signals. Signals in byte format used for synchronization, status, and remote testing.

CRC-6 block error count. The total number of CRC-6 block errors that occur during a timed test interval.

CRC-6 error. The received CRC-6 pattern does not match the computed pattern; this is available only in the ESF mode.

cross-connect. Hardware that interconnects multiplexers with line terminating equipment and other multiplexers. Access to signals is often available through jacks associated with a testboard located near the cross-connect.

crosstalk. Interference in a communications channel caused by a signal traveling in an adjacent channel.

CSU Latching Loopback. Network control code S0110001.

Cyclic Redundancy Check. A method that uses a constant divisor to divide the numeric binary value of a block or frame of data.

Data Circuit-Terminating Equipment. The interfacing equipment sometimes required to couple the data terminal equipment (DTE) into a transmission circuit or channel. Also couples a transmission circuit or channel to the DTE.

data port. The point of access to a computer that uses trunks or lines for sending/receiving data.

Data Service Unit. This unit transmits digital data on transmission facilities. Typically, it interfaces the customer's test equipment (DTE) to a line connecting a dataport channel unit. This allows digital communications without a modem. If the DTE lacks complete digital line interface capability, it may be collocated with the CSU on the customer's site. It may also be a stand-alone unit.

data terminal equipment. Equipment consisting of digital end instruments. Converts user information into data signals for transmission. Also reconverts received data signals into user information.

DATP table. The system configuration chart for the Model 3210 and 3216 Access Control Shelves in the DTAS or MTAS.

DATS maintenance. Involves setting up, revising, and checking the configuration of Hekimian supplied access and test equipment (DTAS and MTAS).

dBm. Decibel (dB) referred to 1 milliwatt. Used as a measure of absolute power values. Zero dBm equals one milliwatt.

dBrn. Decibels above reference noise, where 0 dBrn equals -90 dBm.

DDS Test Unit. Hekimian Model 6302 test set that provides bi-directional DS-1 and DS-0A/DS-0B interfaces. T1 and subrate access and testing require these interfaces.

demodulation. The process of restoring a signal to its original form at the receiving end of a transmission system.

dialback number. The phone number associated with the automatic error reporting function of the DTAS or MTAS.

digital channel. A transmission channel that carries signals in digital form.

Digital Cross-Connect System. A sophisticated digital switch. It can switch an entire T1 line, a group of channels, or one specific channel.

Digital Data System. A system that provides private line, point-to-point and multipoint, duplex data transmission.

Digital group. A basic group of PCM channels assembled by TDM. Usually derived from 1.544-Mbps PCM-multiplex equipment.

Digital Serving Area. The combined geographical serving areas of a set of DDS serving offices. The appropriate tariff(s) specifies this area. The DDS office serving areas that make up a DSA are not necessarily continuous. Also, a DSA may overlap state and associated company boundaries. A typical DSA encompasses one urban area of a single associated company.

digital signal. A signal that has a limited number of discrete states before transmission.

digital system cross-connect. An internal interface that acts as a central point for cross-connecting, rearranging, patching, and testing digital equipment and facilities.

Digital Test Access System. Hekimian's family of digital access and test equipment.

DS-0 DP Latching Loopback. Network control code S0000101.

DS-0 Out of Sync. Network control code S1001100.

DS-0. Digital signal at the 0 level. A BPNRZ signal at the 64-kbps rate.

DS-0A. A DS-0 signal that carries data for only one customer. For subrates, the customer data is byte-stuffed as necessary to obtain the DS-0 signal level. Only DS-0 data signals appear at the DSX-0A.

DS-0B. A DS-0 signal that is the same as a DS-0A signal when carrying 56-kbps customer data. However, this signal can also carry data for several subrate customers. For subrates, successive bytes carry data for different customers so each customer-generated bit appears only once in the DS-0B signal. DS-0B signals appear at the DSX-0B.

DS-1 frame slips. A framing bit is lost or duplicated, but the framing integrity is otherwise maintained.

DS-1 framing errors. The Model 6302 DTU has detected frame synchronization bit errors in either terminal framing (F_t) or signaling framing (F_s) bits.

DS-1 Performance Unit. The Hekimian Model 6301 test set that provides complete in-service monitoring. This test set also provides out-of-service testing of DS-1 signals.

DS-1 Signal Access Unit. A plug-in circuit pack used in DDS hub offices. This unit provides full duplex access to a DS-1 signal. This facilitates centralized maintenance and testing.

DS-1 Test Access Unit Plus. A subset of digital access and test equipment included in Hekimian's DTAS product line. This equipment provides hitless access to T1 lines in both the monitor and split modes.

DS-1 Test Access Unit. A subset of digital access and test equipment included in Hekimian's DTAS product line. This equipment provides split and hitless monitor access to T1 lines for maintenance and testing.

DS-1. Digital Signal at level 1. A BPRZ T1 signal at the 1.544-Mbps rate. The channel data format on the 24-channel line.

DS0-DP. Digital Signal at 0-level Data Port channel unit. A plug-in circuit pack that recovers a DS-0 signal for further connections. Its input and output signals are at 64 kbps.

DSU Loopback. Network control code S0101100.

Dual-Tone Multifrequency. Signaling that uses a simultaneous combination of a lower and higher group of frequencies to represent each digit or character.

duplex. A facility which permits transmission in both directions simultaneously. Also called full duplex.

duty cycle. The percent of a single pulse period (for a "1") during which the voltage is nonzero. The ratio between actual pulse width and the total available time slot.

echo suppressor. A device that detects speech signals transmitted in either direction on a four-wire circuit. This device suppresses echoes by introducing loss in the opposite direction of speech transmission.

EIA Interface. A set of signal characteristics set up by the Electronic Industries Association for standardization. These characteristics include time, duration, voltage, and current.

elapsed bits. The number of bits that have elapsed since the beginning of a timed test.

elapsed time. The time that has elapsed since the beginning of a timed test interval.

Electronic Industries Association. A U.S. organization of manufacturers of a wide variety of electronic products, including telecommunications equipment. It is active in setting industry standards.

Enhanced Monitor/Matrix Unit. An optional component in either a DTAU or Mini-DTAU. This unit performs extensive scanned monitoring of T1 lines.

equalizer. A network which corrects a circuit's transmission characteristics. It may correct for gain-slope (non-linear frequency response) or for delay distortion.

error event. A bit error, BPV, controlled frame slip, CRC-6 block error, framing error, loss of signal, loss of frame sync, or loss of test pattern synchronization.

error free second. These seconds are calculated as 100 x [1 - errored seconds/measurement period]. Is expressed as a percentage. Circuit quality is usually expressed in percentage of EFS.

errored second. Any one second in which one or more of the following occurs: LOS, excessive zero, BPV, framing bit error, CRC-6 error, or frame sync loss. On unframed circuits, error conditions are LOS, excessive zeroes, and BPVs. An end-user may have a different definition of an errored second than the carrier. Also, by some definitions, errored and error-free seconds are tracked only during service availability. For this reason, you can program the error conditions that make up an errored second. In this case, the default is as defined above. AIS and yellow alarms indicate trouble upstream or downstream. As such, they are not error conditions of the line segment being monitored.

excessive zeroes. 16 or more zeroes in a row.

extended superframe. A DS-1 framing format in which the 193rd bit of the bit stream is a shared bit. This means there are 24 framing bits. The 193rd bit follows a 24-frame sequence instead of 12 (superframe). This is the same as using an 8k-bit data channel to frame the signal and identify which frames carry signaling information.

Far-End Voice. Network control code S1011010.

foreign exchange. A circuit between a customer's main station or private branch exchange and a central office. This circuit is different than the one that normally serves the exchange area in which the customer is located.

format errors. Any deviations from the prescribed format of the signal. This includes bipolar violations, low average density, or loss of synchronization.

four-wire circuit (4W). A circuit which uses two electrically separated paths to carry data signals. One path for each direction.

frame error. A frame synchronization bit error occurred in either a terminal framing (F_t) bit or signaling framing (Fs) bit of the superframed format.

frame slip. The deletion or duplication of a frame of data. You detect this by the following event sequence:

1) Two bit errors occur in four consecutive frame synchronization bits.
2) Before declaring an out-of-frame condition, you examine the following 12 bits for correct sequence and bit delay.
3) If the framing bits are in the correct framing pattern sequence, you have a frame slip. The receiver returns to the new frame alignment. No out-of-frame condition occurs.

frame sync loss. In SF, once in sync, two of the last five framing bits (Ft) are in error. In ESF, once in sync, two of the last five framing pattern sequence bits are in error.

frame. On a T1 line, 193 binary digits (24 bytes plus 1 framing bit). Consists of a start flag, address field, control field, data field, frame check sequence, and a stop flag.

framing bit error ratio. The number of framing bits in error divided by the total number of framing bits. This computation does not include any second where there is LOS, SES-OOF, or AIS condition.

framing bit error. In SF, the received frame alignment bit (Ft) or the multiframe alignment bit (Fs) is different than expected. In ESF, the received framing pattern sequence bit is different than expected.

framing bit. A non-information carrying bit introduced into a bit stream. This bit helps separate the characters at the receiving end of a transmission.

framing. A procedure for controlling errors. Consists of inserting bits so the receiver can identify the time slots allocated to each subchannel.

Frequency Division Multiplexing. The process of combining a number of analog signals into a single analog signal by an orderly assignment of frequency bands.

full-duplex. A transmission mode in which information can travel in both directions at the same time.

half-duplex. A transmission mode which permits transmission in both directions, but only one direction at a time.

Hierarchical Storage Controller. An off-board disk and tape controller for clustered VAX computers.

High Capacity Digital Services. This Bell service uses DS-1 digital facilities. These facilities provide communications channels to BOC customers at rates of 1.544-Mbps.

hit. Any disruption of service that lasts for less than one second. (Otherwise, it is an outage).

home. An office that is connected by a final trunk group to a higher class office is said to "home" on that office. Offices do not always home on the next higher class office.

Idle code. A BPV sequence transmitted by the DSU to show that no data is being sent over the line. Network control code S1111110. Also called the Control Mode Idle code.

inband. A signaling method that sends signals over the same transmission line or circuit as the user's communication. These signals are also in the same frequency band as that provided for the user.

jitter. Spurious timing variations in digital pulses over a T1 line.

line. From a switching viewpoint, the loop, station equipment, and central office associated equipment assigned to a customer. From a transmission viewpoint, the transmission path between a customer's station equipment and a switching system.

Local Access and Transport Area. The area served by a single local telephone company.

logic errors. Any change in an originally transmitted signal (that is, 1 to 0). These can be due to cross-talk, jitter, slips, hardware, software, or human errors.

logical. A name you can use in place of or as part of a file specification. These names are easier to remember and type than the full file specification.

long-haul facilities. Facilities used for the inter-DSA portion of an interstate circuit (typically beyond 50 miles).

Longitudinal Redundancy Check. A method to make sure data is received correctly. Consists of performing parity checks across the data message.

Loop Access Test System. A relay connection matrix that provides access to individual customer four-wire local loops and/or to DS-0 (64 kbps) circuits. The matrix is only at DDS hub offices.

Loop Back Select Code. Network control code SYYYYYYY1. The Y's denote the 6-bit code identifying the type of loopback device.

loop signaling. A method of signaling over dc circuit paths. This method uses the metallic loop formed by the line or trunk conductors and terminating circuits.

Loopback Enable. Network control code S1010110.

looping. A test procedure where the received signal returns to its source.

loss of signal. The absence of pulses lasting for one millisecond or more.

MAP (DCS). Network control code S1010001

MAP0 (LSC mapping). Network control code 10010011.

MAPFEV. Non-secondary channel mode, network control code S1111010.

master/slave testing. A test method that allows end-to-end testing without a second operator. A test set (master) at one end controls a test set (slave) at the other end of the line under test.

MJU Alert. Network control code S1110010.

MJU Block Release. Network control code S1111000.

MJU Block. Network control code S0001010.

MJU Branch. Network control code S0101xx1. The xx is the branch number (00=1, 01=2, 10=3. 11=4).

MJU Hub ID. Network control code Sxxxxxx1. The x's are the hub ID. The MJU returns this as two octal numbers.

MJU Loopback. Network control code S1010001.

modulation. The process by which the amplitude, frequency, or phase of a carrier signal varies with one of the characteristics of an information signal.

Monitor/Matrix Unit. An optional component in either a DTAU or Mini-DTAU. It performs basic scanned monitoring of T1 lines.

multifrequency signaling. An inband address signaling method between offices. In this method, 10 decimal digits and 5 auxiliary signals are represented by selecting two frequencies out of the following group: 700, 900, 1100, 1300, 1500, and 1700 Hz.

multiplexing. The compressing of a number of signals into a single composite signal.

Multipoint Junction Unit. This unit is at a DDS hub office. It links three or more segments of a multipoint circuit.

multipoint. A customer circuit with more than two end points. Usually one end point is the control point.

MUX Out of Sync. Network control code S0011010.

nine track. A reel-to-reel, 9-track tape drive used on MicroVAX and larger computers.

number of DS-1 resynchronizations. The number of times the incoming data has lost and regained DS-1 frame synchronization.

OCU Latching Loopback. Network control code S1010101.

OCU Loopback. Network control code S0101010.

off-hook. Station switchhook contacts closed. This results whatever supervision condition shows the in-use or request-for-service state. This may be line current.

Office Channel Unit. A terminal in the central office or DDS serving end office that provides DDS circuit access.

on-hook. Station switchhook contacts open, or whatever supervision condition is indicative of the equipment-idle state.

operation code. The command part of a machine instruction.

outage. Any disruption of service that lasts for more than one second. (Otherwise, it is a hit).

Packet Assembler/Disassembler. This device accepts characters from a terminal or host computer. It then puts the characters into packets that a packet switching network can handle. It also accepts packets from the network. Then disassembles them into character streams that the terminal or host can handle.

parity. A process for detecting data bits that changed during transmission.

percent error free seconds. The percentage of elapsed test seconds that contained no errors.

Point Of Presence. The physical access location within a LATA of a long-distance and/or inter-LATA common carrier. The point to which the local telephone company terminates subscriber's circuits for long-distance dial-up or leased-line communications.

Polar Return-to-Zero. A polar signal with a 50 percent duty cycle.

polar. All "1" bits are the same voltage polarity (either positive or negative). All "0" bits are the opposite polarity from the "1" bits.

portmap. See Test Resource Status display.

private line. A customer leased circuit, not interconnected with the public switched telephone network, for the customer's exclusive use. The private line provides transmission of voice, teletypewriter, data, television, etc.

program circuit. A voice-frequency circuit which has been equalized to handle a wider range of frequencies than what ordinary speech signals require.

Public Switched Digital Service. A service that provides alternate voice and data on a 2-wire user loop.

Pulse Code Modulation. The process that samples, quantizes, and codes the modulating signal (analog). This forms a digital bit stream. Each element of data consists of different types or numbers of pulses and spaces.

quantization. The process that divides the continuous range of values of a signal into nonoverlapping (but not necessarily equal) subranges. It then assigns a discrete value of the output to each subrange. Whenever the signal value falls within a given subrange, the output has the corresponding discrete value.

Quasi-Random Signal State. A specific BERT pattern that can be injected into a channel and sent to a device. Used to test a device's ability to receive a pattern correctly without any bit errors.

Random Access Memory. A solid-state memory device used for transient memory storage. Allows you to enter and retrieve information from any storage position.

read-only memory. A solid-state memory device which has information permanently written into the memory during manufacture.

reboot. To restart the computer from power on.

Relay Access Unit. This unit performs metallic circuit accesses in DTAU or Mini-DTAU.

Remote Access and Test System. Hekimian's menu-driven software used for the access, testing, and maintenance of communications circuits. The framework for a network management system as opposed to just a network control system.

restore. To restore a disk from a backup tape.

resynchronization (framing). During any test, two frame synchronization errors were detected. These errors were in four consecutive frame synchronization bits, and there was no frame slip. As a result, REACT reframes the signal and resynchronizes the pattern.

resynchronization (pattern). During a disruptive or out-of-service test with a known pattern, more than 307 bit errors occurred in a 10-msec interval. (This corresponds to a 1 in 50 error rate.) When this happens, REACT shows a pattern synchronization loss and resynchronizes both the framing and the pattern.

ringing. The process of alerting the called party by the application of an intermittent AC signal (typically 20 Hz) to the appropriate line. When you apply the ringing signal to the called line, you send an audible ringback tone to the calling telephone to show that ringing is occurring.

saveset. The name of a file for a particular backup. A specially constructed file used for storing backup files.

severely errored second. A second which has an equivalent error ratio greater than 1-in-1,000. In SF, a second with one or more LOS or frame sync loss, six or more framing bit errors, or 1,544 or more BPVs. In ESF, a second with one or more LOS or frame sync loss, 320 or more CRC-6 errors, or 1,544 or more BPVs. On unframed circuits, a circuit with one or more LOS, or 1,544 or more BPVs.

short-haul facilities. Facilities that stay within the DSA. Can provide intrastate or interstate services with distances typically less than 50 miles.

signal loss. The received signal has 32 or more consecutive zeroes. Or, the signal is of a received level less than 32 dB below the DSX level.

signal status. The absence or presence of a signal.

single-ended testing. Used for cooperative testing between test units at two points on the analog circuit. Also used for loopback testing.

single-frequency (SF) signaling. A method of conveying dial-pulse and supervision signals from one end of a trunk or line to the other. This method uses the presence or absence of a single specified frequency. Frequently, this is a 2600 Hz tone.

slip. A defect in timing that causes a single bit or a sequence of bits to be omitted or read twice.

split-access testing. Testing in either a loopback or single-end configuration. Loopbacks help sectionalize faults and isolate defective portions of a circuit.

stand-alone. A backup mode used to make backup copies of the operating system.

straightaway test. A test procedure in which one point on the circuit sends a test signal to a receiver at a different point.

Subrate Digital Multiplexer. This unit is in the hub office. It combines several data streams at or below some basic rate (2.4, 4.8, 9.6, or 56 kbps) into a single 64-kbps (DS-0B) signal.

subrate frame slips. A subrate framing bit is lost or duplicated, but the framing pattern integrity is otherwise maintained.

subrate framing errors. Framing bits from the DS-0B signal under test are in error.

Switched Maintenance Access System. This AT&T system provides remote circuit testing for intermediate and end offices. It allows a tester to access and test a circuit without the aid of another tester in a distant office.

synchronization lost seconds. Seconds of lost DS-1 synchronization.

synchronous error measurement. A measurement that, after an error occurs, measures any further errors in that synchronous second. After one second from the original event, the second is marked as a synchronous errored second, and a new measurement begins.

synchronous. Transmissions tied to a single master clock.

system administration. This REACT function deals with the test system setup. It usually covers configuration and operation of the test system.

System Controller Node. The location of the system controller equipment and the system console. The system console allows maintenance of the REACT software. Maintenance tasks include installing, updating, modifying, and backing up the REACT software and circuit databases.

system management. This REACT function deals with the computer setup. It involves setting up and maintaining the configuration of the computer.

T1 Digital Multiplexer. A unit that multiplexes 64-kbps signals into one 1.544-Mbps signal.

T1. The basic 24-channel, 1.544-Mbps PCM system as used in the U.S.

Test Access System. The Hekimian Model 3200 series of test access equipment. This system provides full access to analog and T1 lines for maintenance and testing. For analog circuits in REACT, the TAS provides all-metallic (relay) access.

Test Alert. Network control code S1101100.

Test Code. Network control code S0011100.

test duration. The length of time (hours, minutes, and seconds) a test ran.

test node. The Hekimian and third party equipment located at a remote site. This equipment accesses and tests communication systems.

Test Resource Nodes. These are circuit access points. These points contain circuit access equipment, test equipment, and system controller interface equipment. During circuit testing, testers select appropriate test resources. A Test Resource Status display lists these resources.

Test Resource Status display. This display contains all the test resource information for the REACT System.

Tester Workstations. These are workstations equipped with a video terminal. These workstations are either directly or indirectly linked to the system controller equipment. Indirect connections are through modems, line concentrators, or controllers.

Time Division Multiplexing. The process of combining a number of digital signals into a single digital stream by an orderly assignment of time slots.

tip and ring conductors. The two conductors associated with a two-wire cable pair.

TK50. A 95-megabyte streaming cartridge tape drive used on MicroVAX computers.

Transition In Progress. Network control code S0111010.

Transmission Level Point. A specification, in dB, of the relative level at a particular point in a transmission system. This is referenced to a zero transmission level point.

trunk. A circuit that serves to convert between signal formats used internally in a switching system and those used in the transmission circuit.

TS05. The only 9-track tape drive now available for the MicroVAX II. Also used for the VAX 8200/8300.

TU80. One of three 9-track tape drives now available for the VAX 8200/8300. Also available are TS05 and TU81.

TU81. One of three 9-track tape drives now available for the VAX 8200/8300. Also available are TS05 and TU80.

two-wire circuit (2W). A circuit in which a two-wire path carries signals in both directions.

Unassigned MUX Channel. Network control code S0011000 (data) or S0000010 (data/voice).

unipolar return-to-zero. A unipolar signal with a 50 percent duty cycle.

unipolar. All "1" bits are the same voltage polarity. "0" bits normally are zero volts.

VAX. Virtual Address eXtension. The name of the family of computers that host Hekimian's REACT System.

VMS. Virtual Memory System. The name of the computer operating system for Hekimian's REACT System.

voiceband. A transmission channel with a nominal 4-kHz bandwidth suitable for voice transmission.

volume. Individual cartridges or reels of tape used in backup operations. Often the data does not fit on one volume. In that case, multiple cartridges or reels are used.

yellow alarm. In SF, bit two of every channel is zero for 256 or more channels. In ESF, 16 or more sets of 0000000011111111 or 1111111100000000 patterns have been received in the ESF data link. Yellow alarm is also a remote alarm.